SCHOOL SCIENCE

Vol. XXIX No. 1 MARCH 1991

SCHOOL SCIENCE is a quarterly journal published by the National Council of Educational Research and Training. Intended to serve teachers and students in schools with the recent developments in science and science methodology, the journal aims to serve as a forum for the exchange of experience in science education and science projects. Articles covering these aims and objectives are invited Manuscripts, including legends for illustrations, charts, graphs, etc should be neatly typed double-spaced on uniformly-sized paper, and sent to the Editor, SCHOOL SCIENCE, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016 Each article may not normally exceed ten typed pages.

The articles sent for publication should be exclusive to this journal.

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink. Photographs should be on glossy paper, at least of postcard size, and should be sent properly packed so as to avoid damage in transit

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SUBSCRIPTION
Annual: **Rs 16.00** *Single Copy* **Rs 4.00**

J-10459

A QUARTERLY JOURNAL
OF SCIENCE EDUCATION

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March 1991

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Innovative Evaluation Procedures in Science

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Teachers and supervisors need to evaluate and revise the curriculum to provide for diverse needs, interests, and abilities of learners in the school and class setting. Each pupil needs guidance to achieve optimally.

There are numerous techniques to appraise pupil achievement in the science curriculum. Traditional techniques which seemingly have stood the test of time include:

1. Teacher-written test items. These include true-false, multiple choice, matching, completion, and essay items.
2. Checklists and rating scales. Specific behaviours are listed and each learner is checked (on the checklist) if more guidance is needed to achieve that objective, or a numerical rating (5 = excellent, 4 = good, 3 = average, 2 = below average, and 1 = poor) is given in terms of perceived performance on a rating scale
3. Appraising learner products. Each written paper, art project, or construction item may be appraised in terms of desired criteria.
4. Teacher observation and anecdotal records What the teacher observes as representative learner behaviour may be recorded in a behavioural journal. The date should also be listed with the event.

Additional appraisal procedures will be discussed in the remainder of the paper.

Instructional Management Systems

A school may utilize instructional management systems (IMS) to appraise pupil progress. To develop an IMS takes considerable time and effort on the part of teachers and supervisors in the school/class setting. Generally, at least a year should be given to writing up the diverse sections of an IMS before its implementation. The very first step to follow in developing an IMS is to write precise measurable objectives for pupils to attain in each curriculum area through the sequential years of schooling. Thus, for each grade level and in each curriculum area, there are a certain number of precise objectives that a pupil must achieve. To complete a grade level, a learner then needs to finish the identified number of measurable ends for each subject matter area studied. These are minimal essentials. If a pupil does not complete that which is required for a specific grade level in a given school year, he/she must satisfactorily finish the omitted parts during the next school year. As soon as these have been completed, the learner might then work on measurably stated objectives for the new grade level. Gifted and talented learners, as well as numerous average achievers need to make continuous progress, and thus achieve more objectives than the minimum essentials.

The classroom teacher chooses learning activities for pupils to achieve stated objectives. After this, the teacher measures if a learner has been successful in goal attainment. If so, he/she progresses to the next sequential objectives. If not, the teacher needs to utilize the same or a modified strategy of teaching to guide the learner to be successful in goal attainment.

Advantages given for advocating IMS to evaluate pupil achievement include the following:

1. The teacher can be certain if a pupil has/has not attained any one specific measurable objective.
2. Pupils may know ahead of time what is expected in terms of precise learnings.
3. Parents may also get to know specifically what their offsprings are to learn.
4. Verifiable results may be given to supervisors and other responsible persons desiring knowledge of learner progress.
5. A system of accountability of teachers is in evidence if empirical evidence is available for each learner's achievement Teachers may be held accountable for pupils attaining the pre-specified objectives.

Disadvantages given for IMS include the following:

1. It is difficult to preplan objectives for pupils to achieve. The objectives may need to be preplanned a semester or entire school year before their implementation.
2. Learner having achieved an objective (or objectives) does not guarantee, by any means, the retention of subject matter contained in each end.
3. Emerging objectives in terms of questions and comments come from learners as lessons and units progress. These ends may be perceived by pupils more vital, as compared to adult predetermined measurable goals.
4. Pupils sequence objectives rather than adults. Thus, sequential learnings accrue in the minds of individual learne instructors.
5. Precise measurable goals m trivial learnings,such as specif than worthwhile values, attit solving skills, as well as critic thinking.

Preston and Herman[1] wrote the volving the use of behavioural obj

> Despite the logical appeal of b jectives, many educators and ps not accept them as a final solutio curriculum or the evaluati J.M. Stephens, in an intensive process of schooling, found t largely of spontaneous, un teacher behaviours and that the fect upon pupil learning is no improved by most deliberate in cluding the insistence in some behavioural objectives. He teachers who have a lively inter but who slight objectives even would probably bring about g matter learning than teachers w less but who are punctilious ab objectives.

Learning Centres and Evaluati

Learning centres may be devel ways. The teacher may choose the tasks for each learning centre in Or, pupils with teacher guidance crete and semi-concrete items for well as the related learning experie approach, learners need to seque tasks to complete. There needs to number of experiences in order th omit those tasks perceived as not ful or of personal interest. In a rriculum, described by humanism a of learning, pupils need to cho decisions. The teacher should not dictate objectives, learning activities, and evaluation procedures. Rather, pupils individually need to achieve self-actualization.

A.H. Maslow[2], late leading humanist, indicates the following requirements which need satisfying in order that learners may truly achieve self-actualization.

1. physiological (food, rest, shelter and water)
2. safety (security from danger)
3. belonging (love and affection)
4. esteem (recognition and status)
5. self-actualization (satisfy one's potential)

Combs, et al.[3] state the following pertaining to humanism:

> Perceptual psychology is more than the expression of the humanist movement. It is also a frame of reference specially designed to deal with a question raised by the movement and to contribute to its implementation in the solution of human problems. The humanist movement requires a person-centred psychology, one capable of dealing not only with behaviour, but with the meanings and perceptions that constitute the internal experience of persons as well. Perceptual psychology is uniquely suited to provide this kind of understanding. So it is that the authors of this volume conceive of perceptual psychology as both the expression of the humanist movement and the beginnings of a science through which the humanness of persons can be more adequately understood and the fulfillment of human potential more adequately achieved.

Knowledge is subjective, not objective, to the learner. Thus, adequate emphasis needs to be given to art, music, drama, literature, creative writing, and the social studies at diverse learning centres in the class setting. Adequate emphasis must also be given to subject matter which is more objective in structure, such as science and mathematics.

Advantages given for utilizing humanism, as a psychology of education, to appraise learner progress include the following:

1. Open-ended flexible means may be utilized to appraise progress With pupils being involved in choosing objectives, learning activities, and evaluation procedures, ample consideration needs to be placed upon the quality and ability of learners to make decisions.
2 Pupils must have personal needs met to do well in the school/class setting. Thus, adequate stress must be placed in the evaluation process upon meeting needs of learners to achieve self-realization.
3 Learners need to have adequate knowledge of the self and of others. Thus, a quality evaluation programme needs to appraise pupil's increasing knowledge, skills, and attitudes in the affective or attitudinal dimensions.

Disadvantages given for humanistic evaluation procedures include the following:

1. Learners are not adequately mature to make choices and decisions in the school/class setting. The school's role is to get pupils ready for adult roles in society.
2. A teacher determined curriculum may meet the personal needs of many learners, especially if learning activities are based on motivating achievement.
3. A teacher determined curriculum can be sequentially arranged so that pupils experience continuous progress, thus aiding in effective development of pupils.

IMS Versus Humanism

Teachers and supervisors need to evaluate, rather continuously, appraisal procedures utilized to ascertain learner achievement. Traditional means exist such as using teacher written test items and recorded teacher observations of learner involvement in ongoing learning activities.

Relatively recent evaluation procedures have also appeared on the horizon. These include instructional management systems involving behaviourism, as a psychology of learning. The Missouri Department of Elementary and Secondary Education in their recent brochure entitled *Instructional Management, A Priority for Missouri Schools During the 1980s*, lists the following criteria that effective schools follow:

1. High expectations for learning. Teachers and administrators expect a high level of achievement by all students and communicate their expectations to students and parents. No students are expected to fail, and the school assumes responsibility for seeing that they don't.
2. Strong leadership by building principals. The building principal is an instructional leader who participates in all phases of instruction. The principal is a visible leader of instruction, not just an office-bound administrator.
3. Emphasis on instruction in the basic skills. Since mastery of the basic skills is essential to learning in all other subjects, the effective schools make sure that students at least master the basic skills.
4. Clear-cut instructional objectives. Each teacher has specific instructional objectives within the overall curriculum which are communicated to students, parents and the general public. In effective schools, teachers and administrators—not textbooks—are clearly in charge of the curriculum and teaching activities.
5. Mastery learning and testing for mastery. Students are taught, tested, retaught and retested to the extent necessary to assure mastery of important objectives. Students are not taught more difficult objectives until prerequisite objectives have been mastered
6. School discipline and climate. The effective schools may not be shiny and modern, but they are at least safe, orderly and free of distractions. All teachers and students, as well as parents, know the school's expectations about behaviour and discipline.

Humanism has its supporters in the educational arena. Self-actualization is a key concept in the thinking of humanists. Maslow[4] wrote the following:

> Self-actualization is defined in various ways, but a solid core of agreement is perceptible. All definitions accept or imply: (a) acceptance and expression of the inner core or self, i.e., actualization of these latent capabilities and potentialities, "fully functioning," availability of the human and personal essence; and (b) minimal presence of ill health, neurosis, psychosis, or loss of diminuation of the basic human and personal capacities.

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Water Pollution: What is it?

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Water may also contain biological pollutants. These may be bacteria, fungi, algae or viruses. These organisms are contributed by sewage, unhygienic disposal of waste inside or in the vicinity of water bodies. A majority of these organisms are pathogenic and they cause various problems for humans, plants and animals. Even contact with polluted water may result in infections.

Water is one of the major necessities of life on this earth. The earliest living organisms originated in water. No doubt, now a large number of living organisms lead their life outside water and are called terrestrial organisms. Still, there is no such living organism which can survive without water. Evaporation, transpiration or loss of water in liquid state goes on continuously from the bodies of living organisms, irrespective of whether they are plants, animals or micro-organisms. To compensate for this loss the living organisms must receive regular supply of water, otherwise they cannot survive. This is probably most important reason that life, as far as our knowledge goes, exists on this planet earth only because water is present on earth alone.

Overall degradation in environment is affecting our water resources as well. We very often come across the term 'water pollution'. However, exactly what we mean by water pollution may not be clear to all of us. Let us try to understand this.

I. Anaerobic Condition of Water

It is indicator of bad health of water body. Anaerobic means without oxygen. Normally, water contains sufficient amount of dissolved oxygen. This is available to fishes and other organisms in water and keeps it fresh. When micro-organisms such as bacteria grow in water in high number, consumption of oxygen is more than its replenishment and hence water becomes without oxygen or oxygen deficient. Growth of micro-organisms is the result of high amount of food materials for the micro-organisms being present in water. This happens when water is polluted by organic matter, which serves as food for micro-organisms. You may have seen ditches of dirty water which give out foul smell. And there are gas bubbles rising from the bottom. This happens due to anaerobic condition of water body.

II. High BOD (Biochemical Oxygen Demand)

BOD indicates how much oxygen will be consumed by micro-organisms to completely decompose or finish the organic matter pollutants present in water. Organic matter pollution may be caused due to addition of dead bodies of living organisms, waste food, plant and animal products, excreta of living organisms and so on. The higher the quantity of pollutants, the greater the demand for oxygen. Hence, high BOD for any water sample is indicator of its being polluted by organic matter. Organic pollution may result in growth of pathogenic organisms in water and if the water is consumed it may lead to different types of health problems and even death. High BOD of any water sample can be easily tested. The water sample may be kept in an air tight bottle for four or five days in a warm place. If on opening of the bottle there is strong smell of rotten material, it may be concluded that the water sample has high BOD.

III. High COD (Chemical Oxygen Demand)

This shows how much oxygen will be needed by the water sample so that the pollutants present in water may be oxidised chemically. It is determined by addition of certain oxidising chemicals to water and heating. High COD is also an indicator of water pollution and it is even worse that high BOD, because it can be removed only through complicated processes.

IV. Chemical Pollutants

These may be metals such as cadmium, lead, mercury, chromium, nickel, zinc, copper and so on or they may be oils, grease, alcohols, acids, ammonium, nitrates, phosphates, pesticides etc. Problem with most of these substances is that these are very dangerous and invisible. Minimata disease is caused by mercury. The name comes from Minimata Bay of Japan where this disease was first detected in 1960s. Forty one persons died and many others were affected. It happened because people consumed fish contaminated by mercury. Mercury was released into the bay from industries with effluents and it was present in the body of fishes. People consuming the fishes could not suspect of the fishes being contaminated as neither in water nor in the fishes the mercury indicated its presence. In India, it is estimated that about 6000 tonnes of mercury has already been released into the environment. So far there has not been any report of extreme effects as it happened in Japan. However, if this practice continues we may expect similar effects any time.

Plumbism, which is caused by lead is equally dangerous. It causes mental retardation, sterility, anaemia, bone marrow hardening and even death. It is believed that fall of Roman Empire was caused by lead poisoning. Romans used lead vessels for cooking and storage of food materials including liquors and slowly they poisoned themselves. The same lead is present in high concentrations in many of our rivers and other water bodies. Even ground water is contaminated by lead in many areas. Large number of people use contaminated water because the metal in water is not detectable to users.

There are several other chemicals which may reach water bodies and pollute them. Industries use thousands of chemicals and varying quantities of these chemicals escape with the effluent and mix with water bodies. Similarly, a variety of chemicals are used in houses, those very common being the soaps and detergents. These find their way into water through the waste line. Also, our agricultural practices depend on chemicals in the form of fertilizers, pesticides etc. These chemicals are never utilised by crops in full. Varying proportions of these chemicals reach rivers, lakes, ground water with agricultural run off. The case of DDT is well known. It is contaminating water, food materials and even animal tissues leading to problems. With these chemicals, there is not only one problem of their invisibility and consequently escaping detection but also there is the problem of Biological Magnification. These chemicals get more and more concentrated when they pass from one trophic level to next. For example, if the concentration of a particular chemical is 'X' in soil, it may be accumulated in plants in concentration more than 'X' (say 'Y'). When the herbivores consume these plants, they may accumulate the chemical, and concentration of the chemical in their body may become more than 'Y' (say 'Z'). When the herbivores are consumed by carnivores (which may be human beings), its build-up in the human body may be several times of 'Z'. So, the final consumer which is generally human being is at maximum risk. Also, there is tendency for certain chemicals to associate with particular body molecules. For example, DDT has affinity for fat molecules and consequently, milk may contain much higher concentration of DDT than other parts of body. So, the newly born are at greater risk. There are large number of reports which show that even human milk contains abnormally high concentrations of DDT, and if the baby receives feed regularly there is strong probability of DDT showing adverse effects. DDT and its by-products are known to be carcinogenic.

On several occasions there are cases of fish kills or death of animals due to drinking of water from a river, pond or lake. All this happens because of chemical pollutants present in the water body, and which act as poison Fish kills may be the result of high BOD of water as well, which leads to loss of oxygen from the water body. High BOD is dangerous for human beings and animals which consume the water. High BOD may result in growth of pathogenic micro-organisms in water.

V. Biological Pollutants

Water may also contain biological pollutants. These may be bacteria, fungi, algae or viruses. These organisms are contributed by sewage, unhygienic disposal of waste inside or in the vicinity of water bodies. A majority of these organisms are pathogenic and they cause various problems of humans, plants and animals. Even contact with polluted water may result in infections. It is common in our country that people use rivers, lakes, ponds etc. for bathing, especially during pilgrimages. Kumbh Melas, Ardh Kumbh Melas are famous for such activities. Millions of people take dips in river water on such occasions and within a few days time. In Ganga alone millions of people take baths every year and there are certain spots along its 2000 km long stretch where very large number of people take bath on occasions. Kumbh is one such occasion. Beyond Varanasi, there is a seven kilometre stretch of Ganga where sixty lakh people take bath every year.

Also, river water is carried by pilgrims to far off places to oblige those who do not get the opportunity to reach the places of pilgrimage. The water is used for drinking purposes too. Biological pollutants present in this water can affect those persons who utilise it.

Various common problems caused by biological pollutants are:

A. *Jaundice*: It is a water-borne viral disease and is caused due to mixing of untreated sewage with drinking water sources. On an average 2 lakh people are reported to suffer every year in India and many more cases remain unreported. In 1955, there was an epidemic of Jaundice in Delhi and within 6 weeks 40,000 people suffered.

B. *Polio*: It is another water-carried viral disease caused due to contamination of water sources by untreated sewage. About 50 thousand cases are reported every year from our country and a very large number of cases remain unrecorded. This infection may result into paralysis.

C. *Cholera*: It is continuous diarrhoea resulting in loss of water from the body. It may result in death. It is a bacterial infection of intestine and the main source of infection is contaminated water and food. Unhygienic disposal of waste and mixing of sewage with water sources are the main causes. Cholera may be traced to 7th century B.C. in India. About five thousand cases are reported every year. Actual figure is very high as it is more common in rural areas where no record is maintained. The recorded number of deaths per year is about three hundred.

D. *Typhoid*: It is another bacterial infection which causes ulcers (wounds) and perforations (holes) in the intestine. It starts with fever, rashes, diarrhoea and ends with very high fever. For Delhi alone, around 100 persons per 1 lakh are reported to suffer each year. For rural areas and smaller towns the figure is much higher.

E. *Dysentery*: The symptoms are severe diarrhoea with blood and pus discharges. It may be because of amoebae or bacteria. This is also caused by contamination of water or food and the most important source is mixing of untreated sewage with water sources. About 25% of the country's population in India permanently remains affected by dysentery, either actively or passively.

F. *Diarrhoea*: The symptoms are loose watery motion with vomiting. It is caused by bacteria and results in dehydration (loss of water). Death is very common, especially among children. The main reason is mixing of sewage and contaminated wastes with water sources resulting in contamination and infection.

G. *Helminthic Infections*: Almost each one of you must have encountered the round worm, whip worm, hook worm, guinea worm at one time or the other. About 25% of the population of our country has round worm infection while about 1/3rd of the population has hook worm. These belong to one group of animals called Helminths. The infection is caused because eggs or larvae of these organisms mix with drinking water or food and enter the human body. The source is invariably disposal of untreated wastes and sewage to rivers, lakes, ponds, ground water or in agricultural farms. The symptoms of helminthic infections are anaemia, weakness, pain, debility, mental retardation and in severe cases even death results.

VI. Thermal Pollution

Thermal pollution of water signifies discharge of excess heat to water bodies. It is generally caused due to the discharge of hot water and the source is cooling water which is circulated through boilers, machines, etc., to keep their temperature under control. When the circulating water absorbs heat, its temperature rises. It can be reused after cooling. However, most of the industries which use cooling water do not recycle it but discharge the hot water to river, lake or ocean and take fresh supply of cold water for their use. Result is that temperature of the receiving water body is raised. All living organisms have a certain range of temperature in which they can survive and flourish. So the living organisms in water body receiving heat suffer. Plants and animals living in the water body decrease in number or in extreme cases they may be eliminated totally. Mobile animals and plants tend to migrate away from the zone of thermal pollution if it is possible but those which are of fixed type have to suffer. Also, the heated water cannot be utilized for drinking, bathing, irrigation, etc.

So, it becomes obvious that water pollution may prove highly dangerous. Also, plants and animals may be affected. Very commonly we hear of cases of death of our domesticated animals due to drinking of polluted water. Chemical of biological pollutants present in the water may be the culprits.

The polluted water may cause damage to crops and plantations. Productivity may reduce or the harvested produce is of inferior quality if polluted water is utilised for irrigation. In Doon Valley region, it has been recorded that crop production reduced by about 30% on account of mine wastes mixing with irrigation water. At Khetri, where copper ore is mined and copper is extracted, the wastes generated mix with irrigation water. Result is that not only the crops and crop produces are contaminated but also a very large area of agricultural land has become useless as the production has dropped to such a limit that agriculture has become uneconomical. If you examine the land around any thermal power station, you would find that a very large area has turned non-arable on account of deposition of fine ash which is discharged with the effluent. More or less the same situation exists in the vicinity of other polluting industries, whether these are steel plants, paper mills, metallic ore smelters. Effluents escaping the industries mix with arable soil and convert it into area unfit for cultivation.

VII. Suspended Solids

Suspended solids in the water bodies are another type of pollution. These solids have different origins. They may come from cities, industries, etc., but now-a-days their main source is soil erosion. You might have observed that during rainy seasons, water of most of the rivers suddenly become turbid and if you take some of this water in a glass or beaker you would observe very fine particles suspended in the water. If you filter the water and examine the particles, almost all of it is fine soil. This is because the rain water brings eroded soil into the river. In recent years this problem has grown tremendously in dimension and the main factor is large scale deforestation in the mountains and unscientific agricultural practices. Soil which should be bound by roots of plans and kept in place becomes loose on account of disappearance of the binding factor. Consequently, rain water washes away this soil. In India this problem is going out of control. For example, the average annual sediment load of some Indian rivers is as follows:

Ganga	1250 mg/litre
Brahmaputra	1370 mg/litre
Godavari	1845 mg/litre
Narmada	1494 mg/litre
Tapti	2546 mg/litre
Sabarmati	3143 mg/litre

Source: Prof. V. Subramaniam, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi.

These are the average annual figures. During rainy seasons the loads are much more than during the lean seasons.

Teaching of Chemistry at Secondary Level*

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This paper deals with the methods other than lecture method for teaching chemistry at secondary level. Use of demonstration, simple activities and the various teaching aids has been advocated in the paper making judicious use of the locally available materials. Major concepts of various chemistry topics of Class IX and X books have been analysed and different guidelines have been suggested for teachers for making chemistry teaching interesting, meaningful and more functional for inculcating scientific attitude in the students.

Introduction

With the introduction of 10+2+3 pattern of education, the science curriculum throughout the country has become almost the same. Every student tribal or non-tribal, rich or poor will have to study science and mathematics along with other subjects up to Class X. This is so because the study of science and mathematics are supposed to inculcate scientific attitude amongst the students. It may be another issue whether the scientific attitude (which includes reasoning, trying to find out the causes of effects taking place around us and the tolerance for the views of others) is being developed or not. Are most of the students not studying science and maths without understanding? The same trend of rote memory of the answers of a few selected questions either from cheap guides or from the dictated notes of teachers is going on in most of the schools and it is especially so with chemistry. The author has observed that when we take the students to the laboratory for the first time, there is a special glow on the faces of students. They are more enthusiastic, observant and eager to listen to the teachers and want to do something themselves when they hold the test tubes for the first time in their hands.

In the light of NPE 1986, the books have been rewritten and now there is only one book of science in Class IX and one book in Class X. Effort has been made to integrate different branches of science in one textbook. In Class IX five topics namely (a) Nature of Matter, (b) Periodic Classification of Elements, (c) Chemical Bonding, (d) Chemical Reactions, and (e) Electrochemistry have been included. Metals and non-metals and hydrocarbons find place in Class X. This paper deals with the activities/demonstrations/computer or teaching aids which can be used as supplementary material by the teachers for the effective learning of various concepts of chemistry at the secondary level which is the basis of the would-be scientists of the world.

Nature of Matter

The topic 'Nature of Matter' should be dealt with by adopting the historical approach. Here in this chapter, there should be emphasis on the history of the discovery of protons, electrons and neutrons, Bohr's Burry model of atom and the arrangement of electrons in various shells. Difference between atom and ion may be told on the basis of gain or loss of electrons. Charts and models showing electronic arrangement of common atoms like hydrogen, sodium, fluorine, chlorine, etc. may be used. The atom converts into sodium ion by the loss of one electron and the chlorine atom becomes chloride ion by the gain of electron. This is so because the number of protons remains the same but the number of electrons changes as shown in the following table:

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* Paper presented in the Seminar of Science and Maths Teachers of Bastar District of Madhya Pradesh at Kondagaon, Bastar (M.P.) from 16 to 22 Jan., 1991.

		Charge
Na atom	11p 11e	$+11 - 11 = 0$
Na^+ ion	11p 10e	$+11 - 10 = +1$
Cl atom	17p 17e	$+17 - 17 = 0$
Cl^- ion	17p 18e	$+17 - 18 = -1$
p = protons e = electrons		

While giving the concept of mole, it may be ascertained whether the students have really assimilated the largeness of the Avogadro's number (N) which is equal to 6.023×10^{23}. We may write 6.023×10^{23} as

602300000000000000000000

and ask the students to read and pronounce this number which they will not be able to do. Now we may ask them to think of the possibility of one mole of human beings on this planet, elephants or one mole of aeroplanes. The students have understood this concept if their answer is in negative. The relationship between gram molar mass, molar volume and the total number of atoms, molecules present in a substance can be clarified with the help of the following example:

1 mole of CO_2 gas

$= 6.023 \times 10^{23}$ molecules of CO_2

$\equiv 3 \times 6.023 \times 10^{23}$ atoms

$\equiv 6.023 \times 10^{23}$ atoms of carbon

$\equiv 2 \times 6.023 \times 10^{23}$ atoms of oxygen

$\equiv 22.4$ litres of CO_2 gas at S.T.P. i.e. at 0°C and 1 atmospheric pressure

$\equiv 44$ g of CO_2

After this relationship, the students may be asked to find mass of one molecule of CO_2. The concept of mole may be further strengthened by asking the students to practise for numerical problems.

Classification of Elements

The topic on 'Periodic Classification of Elements' can be taken up by emphasising the need of classification of elements and the various efforts made by our earlier chemists. Doberenier's triads and Newland's octaves should also be mentioned as they do not find any place in the book but Newland's octaves are very much similar to our old musical system.

1	2	3	4	5	6	7	8
Sa	Re	Ga	Ma	Pa	Dha	Ne	Sa

'Sa' in which the sound of the eighth 'sur' was the same as that of first. The long form of the periodic table may be discussed with the help of Periodic Table chart and after giving the students a brief idea of various rules of filling up of s, p, d and f. If it is felt that it is difficult at this level, only the long form of Periodic Table may be shown without having much discussion on it. However, it may be emphasised that the elements of a particular group and a period will have similarity in both physical and chemical properties with regular gradation.

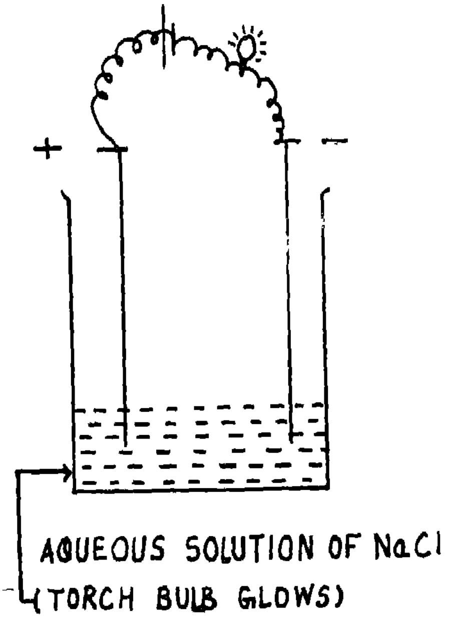

Fig. 1

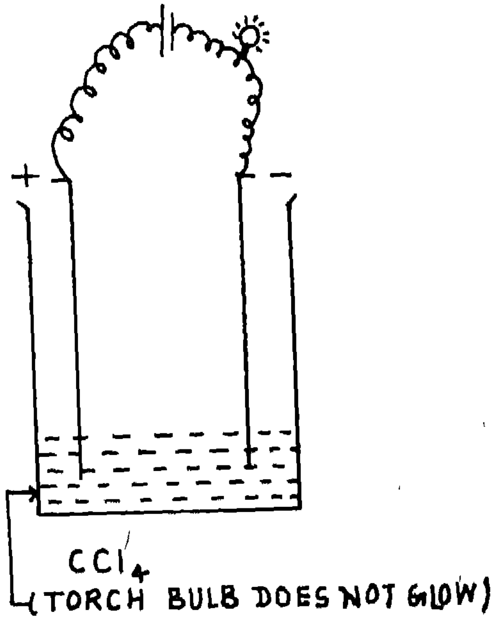

Fig. 2

Chemical Bonding

Chemical bonding is such a topic its teaching is to be taken up only with the help of activities/demonstration by the teacher. Teacher may begin with two compounds NaCl and CCl_4 containing chlorine as a common element. The comparison of solubility in water, reaction with an aqueous solution of $AgNO_3$ and the effect of electric current through the aqueous $AgNO_3$ solution and CCl_4 as shown in the above diagram will automatically force the students to realise that chlorine and sodium in NaCl are bonded in a fashion different that of the chlorine and carbon atoms in CCl_4.

Once thinking has started in the minds of students, they would be ready to understand the causes of bonding and the types of bonding in different molecules. The shape of molecules can be discussed with the help of charts and models. Three-dimensional models of methane, ethane, water and ammonia should be developed with the help of students making use of plasticine or earthen balls and sticks.

Chemical Reactions

Before introducing the topic on chemical reactions, the concept of physical and chemical changes should be recapitulated by showing some simple activities like dissolution of common salt, sugar in water, switching on and off the electric bulb, burning of a candle and the reaction of an aqueous solution of NaCl with an aqueous solution of $AgNO_3$.

Let the students themselves identify and distinguish between physical and chemical changes. Once they understand the concepts of physical and chemical changes clearly, they themselves will list and classify various changes taking place around them.

(a)	$CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$	**Decomposition**
(b)	$2HgO\ (s) \rightarrow 2Hg\ (l) + O_2\ (g)$	
(c)	$Fe\ (s) + S \rightarrow FeS\ (s)$	**Combination**
(d)	$2Mg\ (s) + O_2\ (g) \rightarrow 2MgO\ (s)$	
(e)	$Zn\ (s) + FeSO_4\ (aq) \rightarrow ZnSO_4\ (aq) + Fe\ (s)$	**Simple Displacement**
(f)	$Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$	
(g)	$AgNO_3\ (aq) + NaCl\ (aq) \rightarrow NaNO_3\ (aq) + AgCl$ white ppt	**Double Displacement**
(h)	$H_2SO_4\ (aq) + BaCl_2\ (aq) \rightarrow 2HCl\ (aq) + BaSO_4$ white ppt	

Various types of chemical reactions can be discussed by taking the above examples, *many of which can be easily demonstrated in the class*

Similarly the concept of *slow* and *fast* reactions can be clarified by showing the students that the reactions (g) and (h) are *instantaneous* when we get *white precipitate*, whereas reactions (e) and (f) are *slow* where *decolourisation* of $FeSO_4$ an $CuSO_4$ solutions takes a longer time. Rusting of iron is another example of slow reaction. The concept of exothermic and endothermic reactions can also be taught by showing simple activities of adding water to *quick lime* when *heat is evolved* and dissolving *ammonium chloride* in water when *cooling is caused*. Evaporation of water, spirit and ether are also the examples of *endothermic reactions*. In reactions (e) and (f) if iron is added to zinc sulphate solution and copper added to iron sulphate solution, the students may ask for the reasons for these reactions not taking place. Here it would be in the fitness of things to give the concept of electrochemical series, electrode potential and reactivity of metals which forms the basis of electrochemistry.

Metals and Non-metals

While discussing the chapter on 'Metals and Non-metals', the Periodic Table is to be used as the teaching aid. It should be highlighted that as we go from left to right in a period the metallic nature of an element goes on decreasing, and on going from top to bottom in a group, the metallic nature increases, that is why, Li, Na, K, Mg, Ba, Ca of IA, IIA group fall in the category of metals whereas C, Si, N, P, O, S, F, Cl of IVA, VA, VIA and VIIA group fall in the category of non-metals. Therefore, it can be concluded that the element of IA group lying at the bottom, i.e., Cs should show most metallic nature, whereas the first element of VIIA group i.e., F should show most non-metallic nature. Similarly the concept of reactivity of metals and non-metals can be understood in the light of their position in the Periodic Table. As we go down in a group, the tendency of losing an electron by metals goes on increasing due to increased atomic size. On the other hand when we go down the group situated at the right hand side of Periodic Table, the tendency of gaining an electron goes on decreasing. Because the elements of VIA, VIIA groups, etc., have a tendency of accepting electron to complete their octet, so the *reactivity will depend upon the tendency of gaining an electron*. In VIA, VIIA group this tendency goes on decreasing so the reactivity of elements of these groups *decreases on going from top to bottom*. That is why fluorine is the most reactive non-metal.

Similarly, the reaction of metals and non-metals with acids and bases can be discussed. Acidic and basic nature of oxides of various elements can also be interpreted on the basis of position of elements in the Periodic Table. The oxides of IA, IIA group elements are alkaline in nature which goes on increasing as we go from top to bottom and decreases on going from left to right in a period. When we reach IIIA group, the alkaline nature decreases to such an extent that Al_2O_3 starts behaving as an amphoteric oxide. On further proceeding to IVA and VA group elements, the oxides start behaving as acidic. The acids obtained by the oxides of VA, VIA group elements are stronger acids as compared to oxides of IVA group. That is why CO_2, SiO_2 form weak acids namely H_2CO_3 and H_2SiO_3 but HNO_3 and H_2SO_4 obtained from N_2O_5 and SO_3 are stronger acids.

Hydrocarbons

The chapter on hydrocarbons should be started with definition and emphasis on the word 'only' when we define them as compounds of carbon and hydrogen elements only. The concept of tetravalency of carbon and the three dimensional tetrahedral shape of methane molecule should be clarified with the ball and stick model of methane. Similarly shapes of ethane, ethene, ethyne and benzene molecules are to be discussed. Though the concept of hybridisation is not to be taken at this stage but it may be mentioned in brief and with the help of this concept the shapes of different hydrocarbons can be easily understood. The concept of sigma and Pi bonds may also be discussed to find out the cause of difference in strength of single covalent and double covalent bond. Nomenclature of compounds of carbon is another important aspect to be covered under this heading. Both the systems of nomenclature may be discussed but more emphasis should be put on IUPAC system of nomenclature. Here a brief mention of rules of nomenclature may be made along with examples. While discussing the nomenclature of alkanes, alkenes and alkynes as we proceed from methane to higher hydrocarbons, we come across isomers. Therefore, the concept of chain, position, geometrical and conformation is to be discussed at this level. These concepts can also be amply clarified with the help of ball and stick models and charts. Students should be asked to practise for writing the structures of various hydrocarbons keeping in view the salient feature of tetravalency of carbon. Practice for nomenclature of different simple hydrocarbons would be desirable.

The teaching-learning activity of chemistry as well as other science subjects can thus be made interesting and effective by reducing emphasis on the traditional lecturing and dictation methods and performing more and more simple demonstration activities with the help of teaching aids utilising the locally available resources.

Children's Conceptual Framework about Natural Phenomena and its Implication for Science Teaching

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By appreciating, amongst other things, the perceptions that the learner brings to the class, the teacher can reduce the discrepancies between pupil's intentions and his learning. Similarity of constructed meaning to that intended by the teacher depends on the way a pupil copes with the language used by the teacher during instruction

During the last two decades there has been a major upsurge in interest in science education. Children's informal ideas particularly about the natural and physical environment have drawn attention of many science educators. The ideas which they bring with them to the science class have great implication in science teaching. Recent studies by psychologists and science educators have indicated that children have views about a variety of topics in science from young age even when they have not received any systematic instruction in those subjects whatsoever. These ideas and interpretations are a result of everyday experience—of practical, physical activities and of talking with other people. Their views are often different from the views of the scientists and are frequently not well known by teachers. To children they are often sensible and useful views

Young children, like scientists, are curious about the world around them in how and why things behave as they do. As children attempt to make sense of the world in which they live in terms of experiences, their current knowledge and use of language, they develop ideas which may be called 'children's science'. Although their ideas are less sophisticated than those of practising scientists, some interesting parallels can be drawn. Children, like scientists, view the world through the spectacles of their own preconceptions and many have difficulty in making their journey from their own intuitions to the ideas presented in science lessons. They do come to the science class with already formulated ideas or alternative frameworks and these may be at variance with the theories the teacher wishes to develop. However, these intuitive ideas have a powerful influence on subsequent learning.

When children in a class write about the same experiment they can give various diverse interpretations of it. Individuals internalize this experience in a way which is at least partially their own; they construct their own meanings. These personal ideas influence the manner in which information is acquired. This personal manner of approaching phenomena is also found in the way scientific knowledge is generated. The observations children make about natural phenomena and interpretations of them are also influenced by their ideas and expectations. Same ideas may be shared by many pupils about similar events or same child may have different conceptions of a particular type of phenomenon. Thus a child's individual ideas may seem incoherent. It is important in teaching and curriculum development to consider and understand children's own ideas, their conceptual framework about natural phenomena as it is to give a clear presentation of the conventional scientific theories.

By the time children come to school their expectations or belief about natural phenomena are well developed These intuitions may be poorly articulated but they provide a base on which formal learning can be built. However, in some cases the accepted theory may be counter intuitive with children's own beliefs and expectations differing in significant ways from those to be taught. Such beliefs are referred to as 'alternative frameworks' by Driver (1983). There is evidence from a number of investigations that children have common alternative frameworks in a range of areas including physical phenomena such as propagation of light, simple electric circuits, ideas about force and motion and chemical change as also biological ideas concerned with growth and adaptation. To cite an example from plant nutrition it is very often heard that pupils believe in plants taking prepared food from the soil As regards respiration in plants, children have the notion that plants respire only at night and during day time they only photosynthesise.

It is often noticed that even after being taught children do not modify their ideas in spite of attempts by a teacher to challenge them by offering counter evidence. Children either ignore counter evidence or interpret it in terms of their prior ideas. What children are capable of learning depends, at least in part, on what they have in their heads as well as the learning content which is presented to them. Learning does not occur by the learner responding in a passive way to the environment but by actively interacting with it. It takes place through the interaction between a learner's experience and the conceptual framework he has to give meaning to such experiences.

Pupils as individuals inevitably construct their own purpose for a lesson, from their own intentions regarding the activities they will undertake, draw their own conclusions and carry these through in their subsequent thinking. The fundamental premise is that children tend to generate perceptions and meanings that are consistent with their prior learning. These perceptions and meanings are something additional both to the stimuli and the learner's existing knowledge. When a teacher talks to his class, draws a diagram on the blackboard, discusses a chart or asks pupils to read a textbook, his intended meaning or that of the textbook author is not automatically transferred to the mind of the pupil. Each child in the classroom constructs his or her own meaning from the variety of stimuli present in his environment. To construct meaning, it requires effort on the part of the learner; links must be generated between stimuli and stored information. Teachers must contrive learning situations in such a way that mental constructions made by pupils—what the lesson is about, what is to be done or what can be and what is to be learnt from it correspond with their own intentions. By appreciating, amongst other things, the perceptions that the learner brings to the class, the teacher can reduce the discrepancies between pupil's intentions and his learning. Similarity of constructed meaning to that intended by the teacher depends on the way a pupil copes with the language used by the teacher during instruction.

From an educational perspective it has been argued that it may be necessary to take account of the ideas and beliefs that young pupil bring to their formal study of science if these ideas are to be successfully modified by instruction. The intuitive ideas that students hold prior to instruction are both identifiable and stable and have enough commonality to make it worth planning instructional sequences to change them. The implication of it is that the strategy to be used in any given institutional situation should depend on whether or not children already have many such ideas.

If we adopt a view of learning as conceptual change in its broadest sense then we need to have information about the ideas that students may bring to the learning situation. When students are presented with ideas in science lessons they may fit them into their intuitive ideas and the result may be a mix of taught science and intuitive science. At other times, a student may compartmentalize his or her knowledge and not integrate new knowledge with existing knowledge. When they meet formal science lessons in the school, students have to actively modify and restructure their own ideas. This requires a willingness and effort on the part of the learner. Likewise, if the ideas held by students are to be taken into account teaching cannot simply be viewed as the telling or giving of knowledge to the students. Teaching involves helping each student to construct for himself or herself the accepted ideas. The starting point of a teaching sequence is then the intuitive ideas students bring with them, the conceptual framework they have with them. Having found out the ideas held by students in a class, the role of the teacher then becomes that of diagnostician and prescriber of the appropriate learning activities. Teaching needs to be related to what is familiar to the children not just at the level of the world of events and experiences but also in their world of ideas.

If a science lesson is related to the world outside the classroom in a way which helps the pupil expand his or her knowledge of that world and to make sense of it in a new way, if it is related to prior ideas that the child has already stored in memory he or she is able to fit the lesson into the pattern of his/her existing ideas and experience So to make a lesson interesting it must have relevance to children's everyday life. To be aware of children's existing informal ideas about natural phenomena is important if we are to help them relate these ideas in their minds to the learning experiences provided for constructing new ideas.

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Making Science Teaching More Relevant

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The most disgusting malady of the present system of education prevalent in most of the developing countries is the massive wastage in time spent in learning unnecessary things. The realisation of this fact by the students as well as teachers has potential danger of crippling the whose process beyond repair.

The weakness of one form or the other of the existing educational system has begun to surface in almost all the countries of the world but more glaringly in developing countries. The main point of criticism is that it is mostly irrelevant to the needs of the individual as well as community at large. Primarily, it does not take into account the local environment and thus makes itself foreign to local culture. It has also been pointed out that the present educational system is elitist in nature, largely ignoring the needs and aspirations of the general mass and thereby develops among them a sense of alienation from it. In developing countries, the situation is further accentuated by the fact that a major chunk, as large as eighty to ninety per cent, of the total population lives in rural areas with poor physical facilities for better living. Over and above it, the aspirations and concern of the general mass to improve their living as quickly as possible makes the situation all the more complex. The situation is further aggravated in a country like India having drop-out rate as high as 50% in the first two years of schooling where hardly only one per cent are able to enter institutions of higher learning This situation, apart from leading to wastage and frustration, tends to challenge the credibility of the school system itself. Also the failure of the trained personnel to generate new science and technology and the general unemployability of the systems pose new questions regarding the relevance of the education itself. Thus developing countries are confronted with a formidable challenge of evolving an educational system capable of accelerating the fulfillment of the developmental as well as basic learning needs of the people.

It is remarkable to find that though the problems arising in affluent countries having long liberal tradition in the field of education were not so intense but fundamentally similar to those encountered in others which recently became independent. The rising unemployment is a pointer in the case In view of the above, some of the more radical critics of the existing educational system go so far as to advocate deschooling. Such intense feeling against the existing system is no doubt quite genuine but such advocacy seems to be far too extreme. It appears to be obsessed with the misconception that school should be panacea for all social ills. Such a proposition does not seem to take a total perspective of complex interplay between social, cultural, political and economic structure prevailing in a society.

Education as a Tool for Social Change

The problems of overall societal development are very complex. Development is an evolutional process in historical context, therefore, the strategies to be adopted to achieve it must be in keeping with a stage that a country has reached in this process. Hence, the belief that what is right for the advanced and industrial countries is right for all is far from reality. In all national development, there is a sequence in which political, cultural and economic factors though with much overlapping are successively important. Therefore, the design appropriate to the late stages of development cannot without waste and damage be transferred to the early stages. Many countries have suffered from this oversight. Thus, the advice for transfer of sophisticated and advanced technology from the affluent countries for an accelerated development is untenable and must be challenged. Early emphasis, to my mind, should not be on capital investment but on political and then cultural development. Popular education should play a major role in this groundwork process. In this sequence, importance should be attached to education as the instrument of development primarily building human and social capital as an integral component of economic evolution. Technical training provides skilled cadres capable of handling the task of higher level of economic development. Education also breaks cultural rigidity hindering development. Thus, the problem of overall societal development calls for a comprehensive multi-dimensional and yet integrated plan of action, if they are to be tackled with a reasonable degree of success. In any such multipronged action, education has to act as a stimulant to developmental activities and therefore, it must not be misconceived as a sole instrument to resolve the developmental problems. However, it should not be forgotten that education must contribute effectively towards accelerating the process of development. Education as such should not remain cut off from the real concerns of society, whether these relate to increased agricultural and industrial production, equitable distribution, the solution of the problem of shortage, malnutrition, insanitation and consequent recurrence of local diseases, housing, unemployment, etc. For effectively meeting this challenging task, it cannot afford to be confined only to formal schooling. It must also extend to the non-formal system of education. It will have to respond to both immediate and long-range needs of individuals as well as the community as a whole including the most disadvantaged people living in absolute poverty.

Desirability of Emphasis-shift in School Curriculum

In view of this, the pertinent issue of the relevance of the existing school curriculum arises. Is all what we already have in the school curriculum really necessary? The existing educational system in general has become mainly concerned with responding to changes. It has been lacking in concentrating its attention on preparing new basis for social evolution and development. In fact, it is continuing to follow the path which appears to offer security. Such an attitude is a hindrance to innovation and progress and as such the mortal's main enemy. To make education purposeful and meaningful, it will have to blaze new paths and lay new emphasis over risking the security offered by the existing system. The reformed education, therefore, must be a lively and dynamic process capable of meeting the life-needs and aspirations of the people receiving it, leading to the emergence of a just and open society in which the individual may not only survive but also flourish. As such, it envisages learning direct from the study and observation of real life situations as well as intervention for altering these situations to human advantage. Educational policies and programmes must, therefore, be intimately related with the national goals of social, economic and cultural transformation.

The most disgusting malady of the present system of education prevalent in most of the developing countries is the massive wastage in time spent in learning unnecessary things. The realisation of this fact by the students as well as teachers has potential danger of crippling the whole process beyond repair. There are two aspects of the above referred waste· (i) treatment of the primary education as feed to secondary education and the latter as feed to the tertiary education, and (ii) efforts to make everybody know something of everything. The result is that curriculum becomes burdened with many so-called 'desirables' which are not meaningfully related to the needs of the learners. Naturally, many useful things closely related to practical life do not find place in the curriculum. Moreover, due to illusory lure to catch up with the developed countries, all modern topics having no direct bearing upon the life-situations of the majority of the students are jumbled together in school curriculum which can neither be taught nor be learnt properly in the existing situation of the schools of developing countries. The curricula at different level of education, therefore, must be required to achieve objectives clearly defined for each level in the overall context of basic goals of education. The interfaces between different levels in terms of dependents and independents inputs desirable for each stage must be clearly defined for better results.

A country is constituted of a variety of groups of people such as farmers, porters, smiths, traders, typists, tailors, teachers, engineers, physicians, administrators, etc. All of them do not require the same kind of education. Should we then teach all our students everything like internal structure of an atom or DNA or new mathematics? We cannot afford to continue such a state of affairs. We have to shift the emphasis from scholarship to "education". Since most of the primary students particularly in the developing country do not even go for the education at secondary stage, the curriculum at primary level of education should stress the development of the knowledge and qualities which are universally desirable for every human being. The secondary education, on the other hand should seek to help the individual to link his education with his practical life in future. Thus, while the primary stage curriculum requires to be undiversified foundation-learning, the secondary stage curriculum should have a certain degree of vocationalisation. The point to be stressed in education at the secondary stage is the link between education and life and consequently at this stage more of relevant materials should be taught in a practical way. Hence, so long as a break is not made to the present situation of secondary education being exclusively a feed to the tertiary education, it will continue to be a waste.

· In view of the vastness of the expanse of knowledge already available as well as the rate of knowledge explosion taking place in each branch of specialisation, there is no escape from the stress on specialisation at the tertiary stage of education. Thus, quantum of knowledge desired to be developed in a particular branch of specialisation leading to a degree should be clearly determined at this stage of education. However, it must be realised that to cope with the fast changing nature of knowledge, the curriculum at this stage should not be stratified one but capable of undergoing constant evolution reflecting the needed changes. In the above broad context of general education, I would like to share may personal views on the relevance of science we teach in schools at present.

Importance of Science Education

Without science and technology, the resources of a nation cannot be organised for an accelerated development. Scientists and technologists are required in the infrastructure for an industrial growth. The industries associated with agriculture, housing, clothing and medicine which provide wellbeing to the community rest heavily on personnel with scientific and technical training. This makes obvious the importance of science education in the accelerated development of a country. Particularly in a developing country, it has to be given a concerted and well-conceived boost to catch up with the modern advancement. In the developed industrial countries, the society itself is a training ground for providing technical skills among children, while in the developing countries, technical skills have to be deliberately provided in the schools. Now the natural question arises in one's mind. Is it being achieved through science education in our schools? I am quite sure that what is being done as science education particularly in developing countries is far from being relevant to the needs of the practical life of an individual as well as the immediate requirements of the society at large. It is absolutely failing in generating the manpower that can be immediately put to effective use in solving the existing problems in the neighbourhood. What to talk of secondary school science students, even the degree holders in science can hardly handle with confidence the household electrical gadgets, the pumps used to irrigate fields, the audio-visual equipments used at common places. This is the state of affairs in the realm of formal science education. If we look further at the community in general, the science education is completely alienated from them.

Need for a New Look in Science Education

The entire system of science education has been and is being tried to be built upon wrong assumptions. Perhaps, due to paucity of funds, experimental aspect of science education has been neglected in recent years. The practicals and demonstrations are practically neglected in science teaching at school stage. In fact, the notions that science education can be imparted without proper facilities are being encouraged. This has resulted in creating an impression that curriculum reforms mean only introduction of some more advanced theories.

The second wrong practice is that generally those science graduates who do not get jobs elsewhere are appointed as science teacher. More often, non-graduates in science and sometimes even having no science background at all are required to teach science in schools specially at primary stage of education. Thus, the edifice of science education is inadvertently being laid on a very weak foundation. I am sure that this is the state of affairs in most of the developing countries.

A third wrong tendency of advocating that a graduate in one branch of science can teach any other branch too, has also started getting ascendancy by educational administrators perhaps out of concern for reducing expenditure on science education. Apart from the ability to teach more than one subject, there is another problem of the workload of a science teacher. Practically, no time is available to him for preparing demonstration. What kind of teaching is he expected to impart? Is it possible for him to teach effectively and innovatively? Under the existing situation, if we have a poor science education, we are unjustified in blaming the teachers for the same. The government as well as society allowing to continue such system are to bear full responsibility for the same. When government and society wish to have the benefit of much greater impact o science and technology, they must face these problems and solve them to prevent the considerable damage to the development of a nation after two or three decades when the product o existing science education will take charge of the things. In the above context, some positive step in specific direction are required to be initiated without any further loss of time. To my mind, a concerted effort in the area of instrument technology having stress on improvisation to promote individual creativity suited to meet the challenge of number of students involved and the scarcity of financial resources in developing countries is urgently required.

Further, to attract the highly and better qualified science graduates for teaching at the school stage, attractive remuneration is required. The government must, therefore, make more funds available for the purpose. Simultaneously, ample opportunity for further vertical professional mobility for science teachers must be created Also, courses at higher education stage should be significantly diversified so that a single teacher may be able to handle at least more than one subject particularly in integrated manner as required by environmental approach to science teaching and integrated science at the school stage. Also, the existing arrangement of less qualified teachers with less remuneration for lower stage of education requires to be refashioned. It appears to be more advisable to delink the remuneration from employment at a particular stage of education and to link it with qualification and professional experience. Persons with more experience and better qualification should teach at the lower stage, particularly at primary stage of education. The involvement of science educators at higher education stage in science education at school stage would certainly yield better results in this regard. In addition, such participation will expose them to the urgent needs of science education and thereby generate useful and relevant research topics for them. Thus, the participation in science education at school stage as an important aspect of social service training programmes of all forms of education in science, engineering, medicine and even humanities at the university stage requires to be seriously considered by us.

There is hardly any attempt to improve scientific literacy among the masses and help them to improve at least the sanitation in their home and neighbourhood and thereby prevent the recurrence of some common diseases among them. Neither their wards getting science education in schools nor schools themselves are making any positive contribution to the solution of even trivial problems being faced by the community in their practical life. Now the question arises as to what should then be the main elements of science education if it is to respond to the actual needs of people in developing countries. To my mind, the foremost stress in science education should be to develop capability for adaptability to change. It should also be capable of improving the lot of the poor in the shortest possible time. Particular attention should be given to the activities associated with the problem-solving and decision-making. Problem-solving, most often, needs design-developing and hence there seems to be a need for integration of technology in the teaching of science particularly at the school stage since designing is closely related to engineering and technology.

Again, because majority of the students in developing countries will continue to terminate their studies at primary stage of education for long, the curriculum at primary stage must include work-experience in one form or the other. At later stage, there appears to be an urgent need to give integrated technological bias to the teaching of science particularly at the secondary stage of education. Some attempt in the form of polytechnisation of secondary education has been successfully made in some countries. Even the integrated science and the environmental approach to science teaching have been found to be only marginal reforms incapable of reaching the root of the problem. Keeping in view the mass education as our goal, we can ill-afford to escape from a complete breakthrough in the approach to science education. We must develop a system through which an integrated and coordinated science and technology education takes place in the home, on the farm, in the field, in the industry, etc. and thus become an integral part of community life. At one stage somewhat similar scheme known as 'Basic Education' was envisaged in India and that too by Mahatma Gandhi, one of the few practical and far-sighted men, the world has produced so far. But it was a tragedy that it could not catch the imagination of the Government. The crux of 'Basic Education' was learning through work.

Science Education and Community

Relating science education to daily life specially at the school stage is necessary for several reasons. Firstly, the rapid growth of science and technology is influencing almost all walks of life. In fact, this rapid growth is resulting in the production of altogether new materials, new uses of old materials as well as providing the society powerful tools capable of bringing about changes in his environment. Secondly, a significant portion of the students terminate their studies after primary education and therefore, there is an imperative need to provide them education, informally or non-formally on continuing basis about the ongoing developments in the areas of science and technology having direct relevance to life.

Thirdly, in view of the nature of science, the scientific laws and principles being generalisation of common experiences, the need for relating science with the life of community becomes quite obvious. A comparison between the processes of science and those used in agriculture, health and hygiene revealing the similarity between them also endorse the same view.

Lastly, only of the important objectives of education is to bring about desired behavioural change. If science is taught in isolation, as a body of facts and principles alone, it can hardly meet the above objectives. It is therefore, all the more necessary to make deliberate efforts to dovetail science education with life if it is desired to cultivate scientific temper in the general people.

In a welfare state, manpower is the greatest economic asset and therefore, in countries where majority of the population resides in rural areas, science and technology education requires to be integrated with rural life. However, in considering rural development through transfer of science and technology, one has also to be aware of some characteristic differences between the two in spite of their overlapping common features. Often, one is the generating base for the other and both together accelerate the growth and development.

In the technology-transfer process, the extension and demonstration are two main phases through which people are likely to be motivated and activated for the improved technology. However, its success rests on effective identification of properly motivated as well as adequately trained and skilled individuals who are consumers of the transfer process. Therefore, to ward off wastage and get better results, an advance planning for the development of a comprehensive training programme for the consumers as well as intermediaries in the process is required to be done Such a programme will have to take care of not only technical aspects but also of social and economic aspects.

In the science-transfer process, however, for gradual inculcation of scientific attitudes, impact of science in everyday life has to be illustrated in a simple way which can be understood and appreciated by the rural youth and adults alike. This can only be done by presenting living examples and not through verbal or written abstract communication. Here, the focus of main attack should be against superstition, religious dogmatism fatalistic and philosophical acceptance of destiny of destitution and poverty resulting in consciousness for one's right and responsibilities as well as generation of desire to have a decent, healthier and enjoyable living and love for work to achieve progress With these attitudinal changes, a real self-generating powerful human resource endowed with scientific temper can be developed and this in turn will lead to the establishment of scientific culture capable of taking proper care of all aspects of our social and economic activities.

Such a major change in mental attitude, life styles and social behaviour can only be brought about in rural environment, if proper integration with judicious inter-balance between formal, informal, and non-formal education and varied developmental activities is made. With our experience of the problem of universalisation of elementary education including that of drop-outs and high percentage of illiterate adults, the formal system of education requires to be supported and supplemented by non-formal system of education to effectively cope with the above problems.

Here, I would like to pinpoint the difference mainly between the characteristics of the non-formal education and formal education. Formal education is what is given in schools, colleges and professional training institutions. In this system, the point of entry is fixed, curriculum is framed by state controlled agencies and as such students have no say in the matter and the teachers are full-time professional workers. Incidental or informal education includes all the learning that goes on during our day-to-day life, at home, in clubs, in friendly groups and in society in general. Non-formal education lies between these two systems. Though, it is outside the formal school/college systems, it is not unorganized affair like the incidental education. Non-formal education differs from formal education in many respects like duration, content, characteristics of learners and teachers as well as evaluation. The content as well as duration of a non-formal course are fixed in accordance with the desires of the learners. In it, literacy is introduced only when desired by the learners The only requirement is that the group should desire to learn a particular subject or skill There is no restriction of age of the learners. Here, the teachers need not be traditionally trained in teaching. It may not be an exaggeration if I prefer to say that deprofessionalisation of teachers is one of the characteristics of non-formal education.

It may be emphasised here that there is no escape from well-articulated non-formal system of education if the significant number of drop-outs and illiterates are to be provided some optimum education. To may mind, such articulation requires to be done at school-level education for quick and effective result since this level has a widespread network even in rural areas and also has potential for making inroads into the above mentioned two problematic sections of the population. There is also vast scope to put some input of science and simple technology in such non-formal education. Such topics to be included in non-formal education must be related to the real problem encountered by the learners in their daily life One can have short part-time courses related to health, sanitation, storage of foodgrains, improved technique of farming, cattle-rearing and other occupations. Provision for effective demonstration must be there in such courses if the inputs are desired to be assimilated and put to use by the learners. For example, when a demonstration for comparing the cost of use of iron-pipe with that of bamboo-pipe in irrigation to maximise the water availability to the desired plot from a distant source of water is made to the farmers, they will be quite willing to adopt this simple technology in irrigating their fields. Similarly, when a villager is given a practical demonstration of preparing a low cost hand-flushed water-sealed latrine without increasing the usual expenditure on regular cleaning of wet latrines, I am sure, he will gladly go for such a change. Similarly, demonstration of better use of wastes of domestic animals and garbage converting it into good manures for use in their field can be given to the farmers. Preparation of improved oven to reduce smoke, improved version of bullock carts, improved techniques of lifting water from wells without using diesel or electricity-operated pumps, increasing grinding output through the use of ball bearing based hand-operated *chakky* will go a long way in useful and meaningful education to the rural folks and thereby improve their sanitary, economic and social conditions. Schools must, therefore, act as a resource centre for such non-formal education. Likewise, the school should also educate about the different sources of getting financial and other technical help which are required by the villagers. The necessary forms required to be filled in by them for getting low-interest loan from the banks and fertilizers, pesticides, etc. from government agencies should also be kept by the school to be made available to the individual or group in the locality in case of need.

Continuing In-service Orientation of Science Teachers

The eventual success of any innovative programme depends on the ability of the teacher to handle the materials effectively in the classroom. Any reform in science education, therefore, should include in-service education of teachers. Since the change in the field of science is occurring at a very fast rate, the in-service education should not be a slop-slod affair but continuing in nature. The efficacy of educational technology has been established beyond doubt. It not only enhances the teaching efficiency of the teacher but also the learning rate of the students. The use of educational technology in the training of science teachers is two-fold: (i) it enhances the effectiveness of training process and (ii) also provides teachers with models which show them how technology is used in learning process. The most important aspect of the media-system of educational technology is the simulation of learning environment, the interface between the learner and his environment. In some cases, it also improves the learner's perception through the mechanism of magnification and amplification.

Another important aspect of teachers training is the involvement of teachers in the process of designing instructional materials as well as teaching aids. Being involved so, teachers will certainly become better teachers. One way of motivating teachers is to give awards even in such cases where either some marked improvements in the existing science teaching equipments have been made or altogether a new design giving better results have been developed. Therefore, the inclusion of actual process of design and development of new materials as part of pre-service and in-service training of science teachers must be initiated at the earliest in the developing countries. However, the need to make them capable of developing extraordinarily simple, cheap and multipurpose equipments must be stressed in the developing countries to meet the challenge of cost on account of the number of schools as well as those of students and teachers involved.

Graph Theory: An Introduction

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The main aim of this article is to introduce some basic concepts in graph theory and to make the reader aware of how graphs can be used to solve different real life problems.

A well defined collection of objects is called a set. If S and T are sets then their *cartesian product* is defined as the set

$$S \times T = \{(s,t) : s \in S \text{ and } t \in T\}$$

whose elements are called *ordered pairs*. By a *graph* we mean an ordered pair $G = (V,E)$, where V is a set whose elements are called *vertices* of G and E is a set whose elements are sets each of which contains exactly two elements (called 2-*subsets*) of V and are called *edges* of G. It is quite possible that the set V is empty Such a graph is called the empty graph and is denoted by K_0.

If $G = (V,E)$ is a graph we often write V as $V(G)$ and E as $E(G)$ to emphasize the fact that V is the *vertex set* of G and E is the edge set of G respectively. This notation enables us to eliminate confusion when we will be dealing with more than one graph.

Despite the set terminology in the definition, we usually visualise a graph by means of one of its infinitely many possible drawings on the Euclidean plane. When V is reasonably small, such a picture of a given graph can be drawn on the plane as follows: Represent the vertices of G by distinct points on the plane drawn as small circles. Further, for any edge $\{u,v\}$ in G, draw a Jordan curve on the plane joining the points representing u and v. Note that there are infinitely many such representations of G and the choice of a particular representation depends on the requirements of a given context

Let V be the set of few cities, say, V = {Delhi, Chandigarh, Amritsar, Jammu, Srinagar, Leh} and E be the set of those pairs of these cities which have direct air connection. One of the representations of this graph, usually called the 'air service network' is shown in Fig. 1. Note that in Fig. 1 points labeled 1, 2, 3, 4, 5, 6 denote Srinagar, Jammu, Amritsar, Leh, Chandigarh and Delhi respectively. From this representation it is easy to know which pairs of cities have direct air links and which do not have For example, it is clear that there is no direct air link between Jammu and Leh. According to this air service network, to go from Jammu to Leh we can go

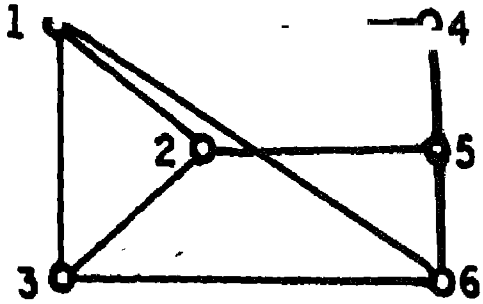

Fig. 1

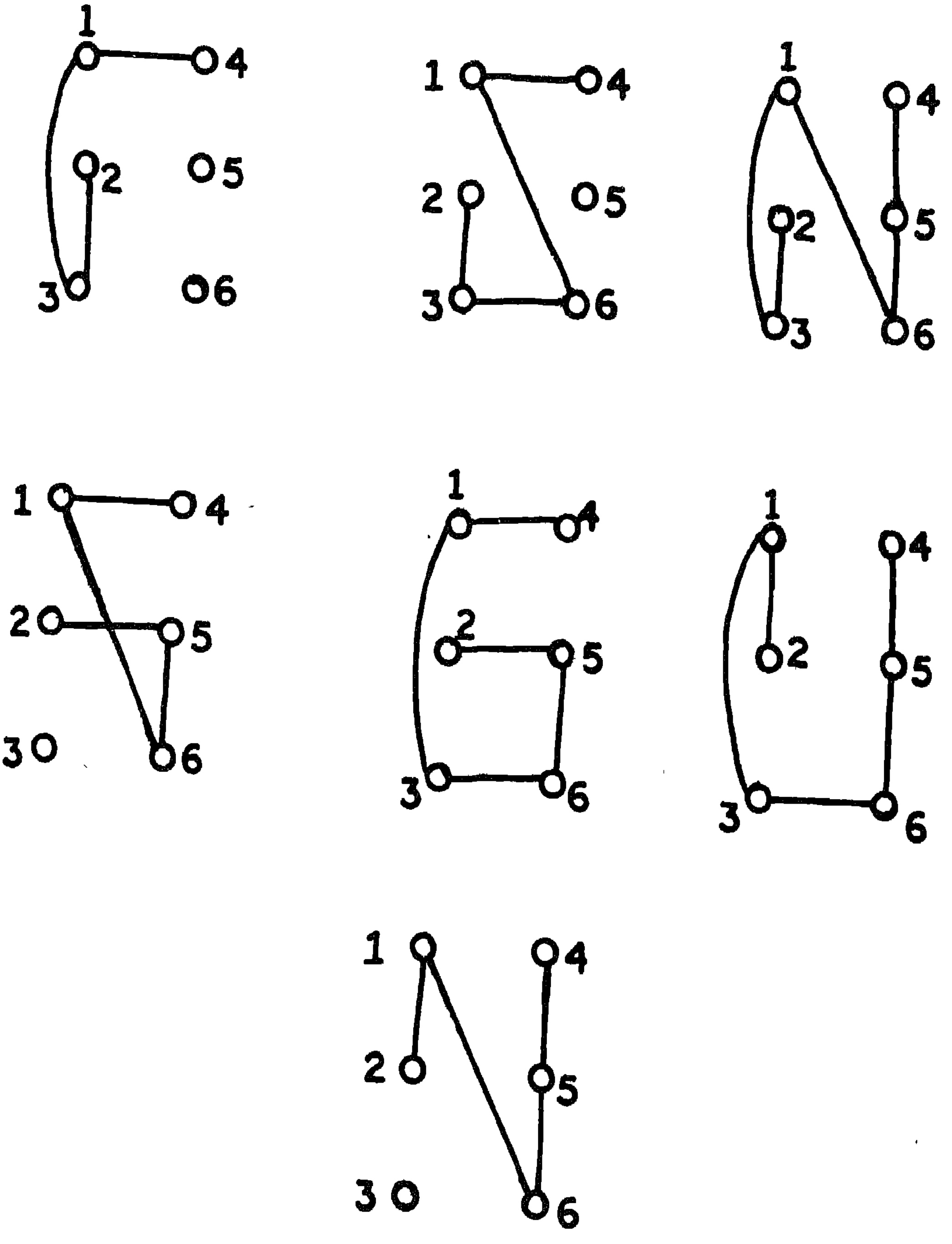

Fig. 2

either via Srinagar or via Chandigarh. We can use other routes also. The selection of a 'proper' route will depend upon the flight timings and other facilities available during the flight. Some of the routes from Jammu and Leh are shown in Fig. 2.

Our task of finding solutions to such problems becomes comparatively easy when we represent them using graphs due to various properties of graphs themselves So, we give some fundamental properties of graphs to substantiate this point of view. For this, let us refer to Fig. 1. From this figure it is clear that Delhi has direct air links to three other cities, namely, Amritsar, Chandigarh and Srinagar. Further, Jammu, Amritsar and Chandigarh have direct air links to three cities each, Leh to two and Srinagar to four cities respectively.

In any graph, for a vertex *u* the number of edges which link it to other vertices in the graph is known as the degree of *u*, denoted *d*(*u*). In Fig. 1, the degree of each vertex is as follows:

Vertices (cities)	Degree *d*
Delhi	3
Amritsar	3
Srinagar	4
Jammu	3
Leh	2
Chandigarh	3

The sum of these degrees is 18 which is an even number. In fact, *in any graph the sum of the degrees of its vertices is always an even number.* Hence, if we divide the sum by 2 the resulting number is the total number of edges in the graph.

This result is due to Euler and is known as the *first theorem of graph theory.*

Theorem 1: The sum of the degree of the vertices of a graph *G* is twice the number of its edges.

This result simply follows from the fact that while counting the degrees of the vertices in the graph each of its edges is counted twice.

The vertices whose degrees are even in the graph are called even vertices and those whose degress are odd are called odd vertices. We may have graphs in which all vertex degrees are even or odd. Graphs *G*, *H* having all even and odd vertices respectively are shown in Fig. 3.

Note that in any graph there are an even number of odd vertices. This simply follows from a property of even and odd numbers, namely, if the sum of a finite number of positive integers is even then the number of odd numbers in the sum must be even.

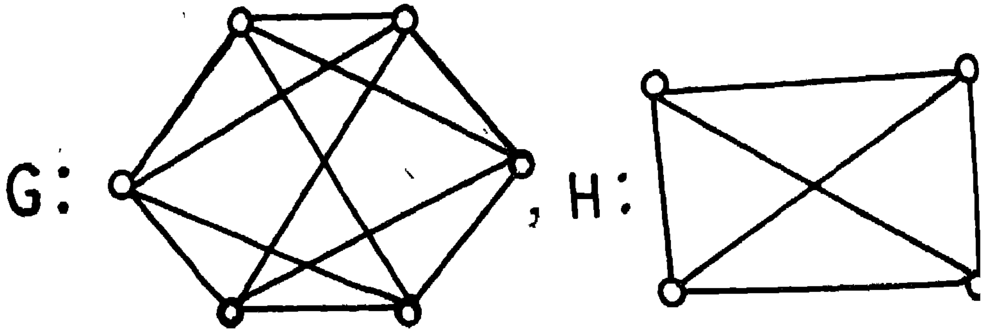

Fig. 3

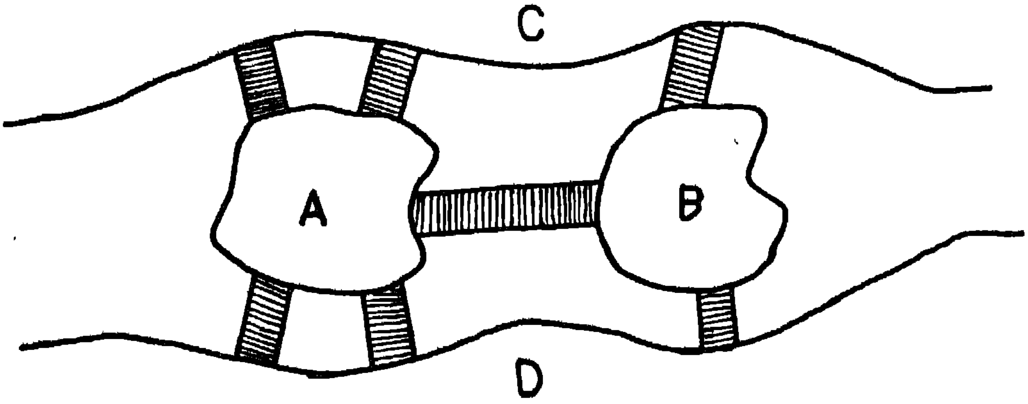

Fig. 4

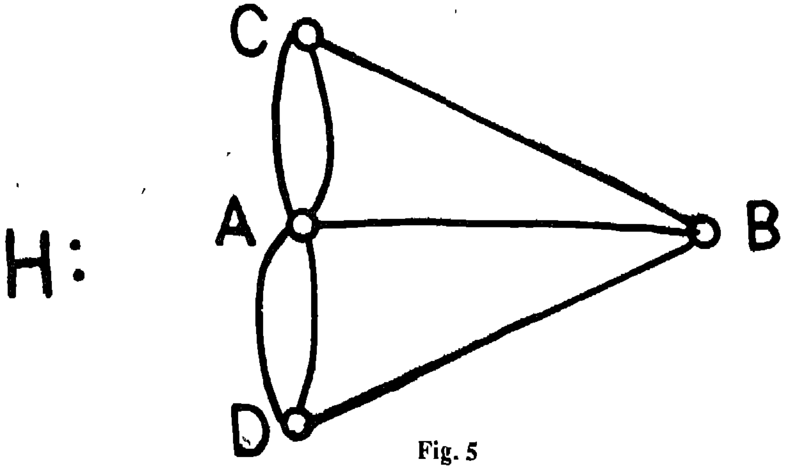

Fig. 5

The graph G of Fig. 3 is a graph in which all the vertices are of even degree. Such a connected graph is called an *eulerian graph*. For this name of three graphs, we have the following story

Through the city of Konigsberg, flowed the river Pregal, with two islands A and B in it. The islands were connected to each other and to the banks of the river by seven bridges as shown in Fig. 4. The problem is to start from any one of these islands and return to it after having traversed every bridge exactly once (other means such as rowing or swimming is not allowed) Coming back to the same island is allowed any number of times during the journey but no bridge should be traversed more than once. Many people could not find such a journey and were convinced that it was impossible to do so. But nobody could prove rigorously that it cannot be done.

It was Euler who proved in 1736 that such a journey was indeed not possible using graph theory as follows·

He replaced each land area by a vertex and each bridge by an edge joining the corresponding vertices. This graph H is shown in Fig. 5 where

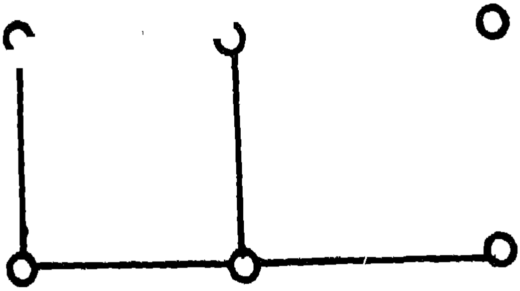

Fig. 6

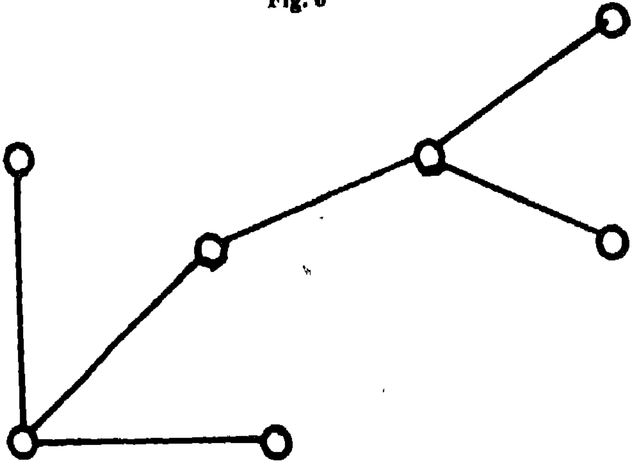

Fig. 7

the vertices are labelled so as to correspond to the land areas of Fig 4. With the help of graph H of Fig. 5 he showed that the problem is unsolvable.

The negative solution to Konigsberg bridge problem led to the discovery of eulerian graphs. A graph G is called an *eulerian graph* if we are able to traverse all its edges exactly once starting from a vertex and returning to the starting vertex.

For a given graph G if we are able to start at a vertex of G and can go to any other vertex of G via an edge then such a graph is called a *connected graph*. For example, the graph of Fig. 6 is not connected while graph of Fig. 7 is connected.

Now, we state the above mentioned result due to Euler which provides a very simple solution to the problem of determining which graphs are eulerian.

Theorem 2: A graph G is eulerian if and only if G is connected and every vertex of G is even.

By settling Konigsberg Bridge problem, Euler (1707-1782) became the father of graph theory. Since then *graph theory* is being used in increasingly many fields of human inquiry—physics, chemistry, biology, artificial intelligence, computer science, engineering and technology, to name a few! The knowledge of graph theory so accumulated over the years since Euler has thus brough immense understanding and progress to mankind.

Telescope to Provide Amazing Look Back into Time

EDWARD WEILER

We believe we'll be able to look back to almost 93 per cent of the age of the universe. So what are we going to see? We have no idea. Maybe we'll see evolution.

The Hubble Space Telescope is a time machine using light to transport astronomers on a bizarre journey back into the past—almost as far back as the beginning of time.

The powerful space telescope, recently placed in Earth orbit by astronauts aboard the American space shuttle Discovery, is expected to unlock the mysteries of the universe and provide a clear view of some of the most distant and youngest objects in the universe.

The revolutionary telescope was released into an orbit 608 kilometres above the Earth by the astronauts aboard the space shuttle Discovery on April 25. This is the higher orbit the shuttle could reach carrying a payload as heavy as the space telescope, and is about twice as high as shuttles usually go. This altitude will enable the telescope to operate safely above Earth's obscuring atmosphere, and also keep it from spiraling Earthward too quickly due to atmospheric drag.

Because of the Earth's distorting atmosphere, the biggest ground telescopes can see no farther than 10,000 million light years and provide only fuzzy pictures. The space telescope is expected to see light that is 14,000 million years old, light that started hurtling towards Earth shortly after the "Big Bang" that astronomers believe began the evolution of the universe.

"We believe we'll be able to look back to almost 93 per cent of the age of the universe," says Edward Weiler, a space telescope programme scientist with the National Aeronautics and Space Administration (NASA). "So what are we going to see? We have no idea. Maybe we'll see evolution."

The deployment of the telescope was delayed by about 1 hour and 40 minutes because of problems in extending one of the telescope's two solar panels. The solar arrays produce electricity from the sun's energy, providing critical power to the spacecraft's cameras and scientific instruments. The balky solar panel, rolled up in a cartridge prior to deployment, had stuck twice before ground controllers succeeded in unfurling it by overriding a computerized tension sensor. The launch itself had been delayed two weeks. Scheduled for April 10, the launch was aborted four minutes before lift-off when an auxiliary power unit failed. The power unit is one of three that steer the shuttle's three engines, control the movements of flaps on the wings and rudder, and provide the hydraulics to lower the ship's landing gears and operate the brakes.

The space shuttle finally blasted off from Kennedy Space Center in Florida on April 24 to begin its five-day flight. The following day it released the telescope and then backed off about 70 kilometres and trailed it for the next two days in the event that ground controllers were unable to

The Hubble Telescope

The Hubble Space Telescope was named after the American astronomer Edwin Hubble, who developed the theory that the universe was formed in the "Big Bang" 15 billion years ago and has been expanding ever since. The telescope weighs 11,000 kg and is roughly the size of a big railroad tank car. It looks like two huge cylinders joined together and wrapped in metallic silver insulation. Wing-like solar arrays extend horizontally from each side of the cylinders and dish-shaped antennas stretch out above and below the body of the telescope.

The telescope is made up of three major elements: a support systems module, which includes the exterior structure of the telescope; the optical assembly, which contains the telescope's two mirrors, said to be the finest, most accurate and most highly-polished ever made; and the five scientific instruments.

The Hubble telescope works like a conventional double mirror telescope. Light enters and strikes a large mirror, which reflects images into a smaller mirror, which in turn bounces the light back through a hole in the centre of the first mirror to a local plane where the scientific instruments are located.

The scientific instruments include the following:

— The wide field and planetary camera to survey vast areas of deep space and take vivid pictures of planets in the Earth's solar system. This instrument will be used to study the nature of quasars, thought to be the most distant objects in the universe.

— The faint objects camera to provide detailed images of extremely faint objects such as white dwarfs, stars that have cooled and collapsed near the centre of the Milky Way. Studying them will shed light on the evolution of stars.

— The high-resolution spectrograph will enable studies of ultraviolet emissions from very bright objects, such as the nuclei of active galaxies, supernovas and exploding galaxies.

— The faint object spectrograph will record the faint light from very distant galaxies and reveal how galaxies were formed.

— The high-speed photometer will be needed to measure the intensity of light from distant and variable sources in space. This instrument may be able to prove, for the first time, the existence of black holes by measuring bursts of radiation emitted by matter that scientists believe quickly orbits a black hole before falling into it.

Data from the telescope will be relayed by satellite and ground stations to NASA's Goddard Space Flight Center for processing and then to the Space Telescope Science Institute in Baltimore, Maryland, where it will be analyzed and stored in permanent archives. Eventually observers around the world will be network to the institute, enabling them to have computer access to the data.

The space telescope was developed by NASA with contributions from the European Space Agency, which provided one of the observatory's key science instruments—the faint object camera—and the solar panels used to convert the sun's energy into electricity.

The telescope, designed for an expected lifetime of 15 years, will be remotely controlled from Earth and will operate round the clock, day and night, seven days a week, year after year, unaffected by clouds and weather. Shuttle astronauts will visit the space telescope about every five years on servicing missions, during which they will use the shuttle's long mechanical arm to pull in the observatory and mount it on a platform in the orbiter's open payload bay. Astronauts, wearing space suits, will then go out into the bay to complete the maintenance, which may include changing the spacecraft's solar arrays, scientific instruments, or any of the more than 70 modular units that can be replaced in orbit. The replacement units, ranging in size from a shoe box to a telephone booth, are accessible behind doors on the exterior of the telescope and can be removed or installed with the aid of wrenches and screwdrivers.

According to NASA officials, new technology will make it possible to design more sophisticated scientific instruments over the years, and some of the telescope's instruments will be removed and replaced with state-of-the-art detectors to increase the spacecraft's power of observation. Several improved instruments are already under development and could be installed within next five years

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open the telescope's aperture door and a rendezvous and spacewalk were required to perform the task manually.

The aperture door, a three metre wide aluminium hatch that was used to close off the telescope's front opening to protect its large super-polished mirror from dust and contamination from the shuttle's jets during deployment, had to be opened before the telescope could be adjusted and focused on the stars. There was a delay in its opening when engineers on the ground were unable to make contact with the telescope's primary antenna, but they finally established a link and got the lens cover to swing open.

The door-opening motion jarred the telescope more than had been expected, however, causing two of its four position-stabilizing gyroscopes to stop working. The telescope automatically went into a safety mode that keeps it from inadvertently pointing toward the sun or other bright surfaces that would damage the telescope's delicate scientific instruments. Ground controllers then began a step-by-step procedure to bring the telescope's electronics back on line.

Engineers activating and testing the various systems on the telescope also encountered trouble communicating with the spacecraft's main antennas, which are to be used to relay scientific information back to the Earth. The dish antenna was pressing against a protruding electrical cable and was unable to swivel as far as necessary to lock onto a NASA relay satellite needed to transmit pictures and other data to Earth. Engineers managed to reposition the problem antenna through the use of radio commands.

Scientists could not begin the process of powering up and calibrating the telescope's scientific instruments until the antenna problem was resolved. Adjusting all the telescope's complex scientific instruments is expected to take several months, after which the actual scientific research will begin. But NASA officials said early tests indicate that all the scientific systems are performing normally and the first image received from the telescope is a picture of a star cluster in the southern constellation Carina.

"We had a spectacular mission, an incredible opportunity to be a part of what I think will be one of the most historic events the space shuttle programme has ever figured in," astronaut Kathryn Sullivan told reporters soon after Discovery's return to Earth.

The largest and most complex scientific instrument ever put into space, the Hubble telescope is expected to enable researchers to peer five times more deeply into space, detect objects 50 times fainter and view them with 10 times finer detail than is possible with the largest Earth-bound observatory. It will allow astronomers to study distant stars and galaxies, determine the age and size of the universe and see whether it is expanding or may at some point collapse on

Hubble Reveals Double Star

The first images sent back by the Hubble Space Telescope have excited scientists by revealing the existence of a double star that ground-based telescopes could not detect.

The photos taken May 20, which were part of an initial engineering test and not a demonstration of the telescope's full capabilities, showed bright, crisp stars twice as sharp as those seen in pictures taken by ground-based telescopes of the same part of the heavens.

"Fantastic," said James Westphal of the California institute of Technology and principal scientist for the wide field camera used to take the first photos. "We are just as pleased as punch at this point. Our image is significantly better than we were concerned that it might be."

The rare binary star, located in an open star cluster in the southern constellation Carina, had appeared as a single blur of light in earlier images taken from Earth. "We didn't know it was a double star," Westphal said, "So already we've learned something we didn't know."

Engineers started the so-called "first-light" images—the term astronomers use for the initial images from a telescope—by sending programmed instructions to Hubble. The telescope moved to point directly at the target stars. Then the telescope's wide-angle camera opened its shutter for a one-second exposure and then for a 30-second exposure. The images were recorded on board as 10 million bits of data, which were then sent through a communications satellite and a ground station in New Mexico to Hubble's control centre at Goddard Space Flight Center in Greenbelt, Maryland.

itself. It is also expected to solve the mysteries of quasars, black holes and other cosmic phenomena, and may even find stars with planets that could conceivably support life.

Quasars are thought to be some of the most distant objects in the universe, and although they appear to be no bigger than a large star, each produces hundreds of times as much radiation as an entire galaxy of stars. Astronomer James Westphal of the California Institute of Technology says that when the light from a quasar 10,000 million light years away first began its intergalactic journey, the Earth's Milky Way was nothing but a swirling cloud of cosmic dust and gas.

While the quasar's light travelled for thousands of millions of years, this dust and gas coalesced to form the 100,000 million stars of the Milky Way, including our sun and its planets. As the light now reaches the solar system, life on Earth has evolved enough for a man to orbit a space telescope above the atmosphere with instruments that can detect the light.

"Meanwhile the quasar has continued to change," Westphal says, "and it's likely that it doesn't even exist anymore now." Astronomers are seeing the image of the quasar as it existed 10,000 million years ago.

Astronomers believe that the mysterious quasars, thought to exist at the very limits of the observable universe, may be explosions that precipitate galaxies—the violent first step in an evolutionary process that gradually results in a normal galaxy like the Milky Way. Quasars are too far away to study in detail from Earth, but with the great sensitivity of the space telescope, astronomers may finally be able to determine what powers these cosmic dynamos.

The central "engines" of quasars are thought to be super-massive black holes, caused by the collapse of millions of stars. The intense gravitational pull of these black holes, whose existence is theorized but not yet confirmed, creates giant accretion disks of swirling matter from nearby stars that are being pulled into the black holes like whirlpools circling into a bathtub's drain. Quasars also emit perplexing jets of glowing matter from their central regions.

"Perhaps quasars are the first forming of matter," Weiler says. "They have huge black holes and jets, and somehow galaxies formed around them. Perhaps all galaxies have quasars at their nucleus. We still don't know."

The powerful new telescope will also explore the ultimate fate of the universe. Astronomer Edwin Hubble, after whom the telescope is named, determined that most galaxies are speeding away from the Earth as the universe expands from the original Big Bang explosion.

By studying bright, exploding stars called supernovae in distant galaxies, scientists hope to determine the rate at which the expansion of the universe has been slowing due to the pull of gravity. If this deceleration rate is small, astronomers believe the universe may continue to expand forever. However, if the slowdown is occurring more rapidly, then eventually the expansion will come to a halt and the cosmos may be destined to collapse back on itself.

"To attempt to find an answer to this question, what we need to do is plot the velocity of galaxies at farther and farther distances," Weiler says. "To do that we need mileposts in those galaxies, very bright mileposts so that we can see them very far away. Supernovae are excellent mileposts."

One of the major scientific objectives of the telescope will be to calibrate accurate distance maps of the universe. Precision tracking instruments will point the telescope towards reference stars to measure their exact positions. Current estimates of distance are just that, educated guesses. Stars may really be twice as far away as scientists think they are, or just half as far away.

Astronomers also hope to obtain for the first time an accurate determination of the Hubble constant, a famous parameter of value that is currently disputed. The Hubble constant is used to calculate how fast a distant celestial object is receding from the Earth due to the expansion of the universe and how far away it is in space and time.

The telescope will also zoom in on details of planets in our own solar system to show their weather patterns and surface markings, and will provide the first images showing features of Pluto, the outer-most planet of the solar system.

Scientists call the new space observatory the most amazing telescopic advance since Galileo first peered at the stars through a primitive telescope some 400 years ago.

"The space telescope will provide astronomers and the public with a wondrous new sailing ship to explore the vast ocean of space and provide important new clues of solving some of the ultimate puzzles that humans have pondered since they first looked up into the dark night sky," said Edward Weiler, NASA space telescope programme scientist.

Requests to use the observatory have bombarded the Space Telescope Science Institute in Baltimore, Maryland, who will manage the data. The institute has approved time for 162 observations during this first year from more than 550 proposals submitted by astronomers in more than 30 countries.

Some observing time has also been allocated to amateur astronomers, including a computer scientist, a high school science teacher and a self-employed museum volunteer. They will use the powerful telescope to search for massive proto-planets or investigate magnetic fields around peculiar stars.

"I expect that amateur astronomers will use the Hubble Space Telescope to ask refreshing new questions," says Riccardo Giacconi, director of the space institute, "and that their findings will make a real contribution to the advancement of astronomy."

Courtesy: *Science Update* (USIS)

Science News

Scientists Puzzled by Elusive Greenhouse Gas

Scientists are puzzled by the mysterious disappearance from the Earth's atmosphere of vast quantities of manmade carbon dioxide, the chief "greenhouse gas," and a major effort is under way to find out where it is going.

Scientists estimate that about 6,000 million metric tons of carbon are pumped into the atmosphere each year in the form of carbon dioxide caused by burning fossil fuels, like coal and oil, and by cutting and burning forests. However, only about half of this carbon dioxide lingers in the air, where it traps heat that could lead to global warming. The mystery is what happens to the other half, more than 3,000 million metric tons of carbon that is somehow removed from the atmosphere each year.

The global hunt for the carbon "sink," as scientists call the unknown mechanism that accounts for most of the disappearance, is more than just a matter of satisfying scientific curiosity, says Lee Klinger, a research scientist at the National Center for Atmospheric Research in Boulder, Colorado. Learning the many sources and sinks of carbon is crucial in predicting how rapidly global warming will occur. But a more alarming theory is that vast quantities of carbon dioxide now being stored somewhere on the planet could be released suddenly by some triggering event, with potentially catastrophic results.

Possible sites of a sudden release of carbon dioxide include the world's oceans, which for years have been storing dissolved carbon at great depths, and the vast forests of the northern hemisphere—especially marshy peat lands and bogs—that together absorb more organic carbon than all other terrestrial land systems combined.

"If certain changes occur, such as increased warming, it could cause this carbon to be re-released as carbon dioxide, causing a potentially serious situation," Klinger says, "because then we not only have all the carbon that's already in the atmosphere, but we have this additional carbon that was being taken out over the years now being put back in, hastening the suspected global warming trend."

Scientists say that in 1986 a violent event—such as a volcanic eruption, landslide or earth tremor—caused Cameroon's Lake Nios to suddenly spew into the air carbon dioxide that had been stored on its bottom. The ground-hugging cloud of invisible gas killed 1,700 people as it crept across the land.

The oceans have long been suspected as a major depository of carbon dioxide. However a new study suggests that the sea is taking up far less carbon than is disappearing from the atmosphere. The authors of the study, published in the journal *Science*, believe the bulk of carbon dioxide created by the burning of fossil fuels is being absorbed by some mysterious process occurring on land, probably in the soils and plants of the forests of the northern hemisphere.

Scientists have not yet identified the specific plants or regions of the planet, but one of the prime suspects is peat lands and bogs, which absorb large amounts of the gas. Peat is a highly organic soil found in marshy regions composed mainly of decayed vegetable matter.

Even though peat lands make up only 10 per cent of the Earth's vegetated land surface, Klinger says, "there is more organic carbon in peat lands than there is in the entire ocean system. That's why peat lands over the last few years have become a major focus of research in the atmospheric chemistry community."

He says field studies suggest that increased global warming could cause the peat lands to start losing their stored carbon by killing the mosses, the dominant plants in bogs and peat lands chiefly responsible for their carbon build-up.

"There is the potential for the carbon that's stored in these peat lands to be lost," he says. "Keep in mind that carbon is not only carbon that was derived from fossil fuel burning over the last several decades, it's also carbon that was stored many hundreds or even thousands of years ago. That's a pool of carbon equal to all the carbons contained in the atmosphere right now."

Courtesy· *Science Update*

Environmental Damage in the Gulf

The United Nations Environmental Program (UNEP) has begun to develop "an objective, independent assessment" of the effect of the Persian Gulf fighting on the environment in the Gulf, not only from oil spills but also if chemical and biological weapons are used.

Mustafa Tolba, UNEP executive director, said at a February 6 press conference at UN headquarters that "we are not only concentrating the effort on the oil spill, disastrous as it is, but on any possible damage ... and the role of the UN in reconstructing what has been destroyed in the field of the environment."

Tolba said he is also trying to alert everybody about the potential environmental danger that could come from such sources as the destruction or release in the atmosphere of any chemical weapons or substances or any biological weapons.

He said he is especially concerned about the possible impact of biological weapons because they can be "seriously damaging" as compared to chemical weapons which "don't disperse over wide areas."

Bacteriological organisms "live in the atmosphere for 40 to 50 years and they could be pushed by wind from the area of the war up to probably the northern part of Europe," Tolba added.

While bacteriological weapons could have the most devastating effect over the long term, Tolba said, most of the casualties from the use of chemicals would occur on the battlefield.

Tolba said his staff is in touch with the United States and other members of the coalition of their military assessment of Iraq's biological weapons, the effect of coalition bombing of biological weapons factories, and the allies' assessment of the danger. Tolba said he is trying to get such information from Baghdad as well.

Fourteen UN agencies—including the Food and Agricultural Organization, the International Maritime Organization, UNICEF, UN Development Programme, IAEA, UNESCO, and the World Health Organization—are meeting in Geneva to begin preparing the environment plan, according to Tolba. UNEP does not want to be involved in the political aspects of the Gulf war, he said, "our business is the environment as it influences human life."

Damage to Rich, Fragile Ecology

According to environmental experts, the rich and fragile sea life system of the Persian Gulf is being battered by the worst known oil spills in human history.

The first spill, discovered January 24, was between 91 and 227 million litres and covered an area of 350 square miles (910 square kilometres) It is believed to have been caused by Iraqi forces who released more than three million barrels of crude oil into the Gulf from occupied Kuwait.

A six-member team of American environmental experts, headed by the US Coast Guard and including representatives from the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the Army Corps of Engineers and the Navy Supervisor of Salvage, reached Saudi Arabia January 27 to help that nation clean up the spill. US military forces also took action to stem the flow of oil by bombing two manifold pipe systems that control the release of oil from inland tanks Oil stored in five tankers anchored off Kuwait are also believed to have been emptied by Iraqi forces into the Gulf.

More than half of the oil has since evaporated. The support from the United States, Canada, Japan and Brazil and the equipment available in the region would be sufficient to clean up the spill in about a month and a half, if "the situation was normal," Tolba said.

UNEP is coordinating with US, Canadian, Saudi and other teams in the region to determine the scope and impact of the spills. The other Gulf nations (Bahrain, United Arab Emirates, Oman and Qatar) as well as Iran and Iraq were also asked to report on the spill from their perspective.

Mark Whiteis-Helm, spokesperson for the Friends of the Earth, an American environmental organization, said important commercial fisheries may be ruined, rare animals destroyed and supplies of human drinking water imperiled by Iraq's dumping of oil.

"It is a very rich area and a fragile ecosystem," he said The Gulf supplies people with food and the water that Saudi Arabian plants desalinate for use in drinking, he added.

Whiteis-Helm said not enough is known about the oil spill to judge the long-term environmental consequences. But a much smaller leakage of oil in 1983 resulting from shelling of drilling platforms in the Iran-Iraq war decimated sea life in the Gulf for a number of year, he said.

Other oil has fouled some of the beaches of northern Arabia because of Iraqi hits on a refinery just south of the border with Kuwait. News pictures of oil-soaked birds come from the shore near the refinery, according to officials. The Persian Gulf is a relatively shallow body of water, they say, with few rivers emptying into it, which means that pollutants are not readily flushed out to sea.

Environmentalists are also concerned about the effects of burning oil facilities on the atmosphere. The black plumes of smoke that rise from burning storage tanks in Kuwait are spewing pollutants into the air but are not so large at the moment that they pose a danger to the environment, Whiteis-Helm said.

"But if the 360 pressurized oil wells (in Kuwait) are blown up by the Iraqis it could take months or years to put out the fires. We think that could affect the onset and duration of the monsoons," he said.

The monsoons are the moisture-laden prevailing winds which blow across the Indian Ocean. From April to October they blow southwest to northeast from the cost of Africa toward Iran, South Asia, and Southeast Asia, bringing vital seasonal rains. From October to April the winds reverse direction, bringing rain from the northeast to western Africa.

Courtesy: *Science Update*

Study of Ozone Layer by Spacecraft

The spacecraft *Galileo* swooped around earth as it skipped through the solar system and flashed back reports of a cosmic phenomenon that may be destroying the ozone layer, scientists said. Scientists at the Jet Propulsion Laboratory in Pasadena, California put on a celestial slide-show and told reporters *Galileo* had sent back valuable data over a seven day period while it was near earth.

Dr. Bob Carlson, one of the *Galileo* scientists, said that the craft had detected something that could shed new light on the way the ozone layer—the protective barrier that shields the earth from the sun's deadly ultra violet rays—is being depleted.

Data sent back by *Galileo* showed a cloud in the stratosphere almost 16 km above Antarctica. Such clouds are known to form in the southern hemisphere's winter, in September and October.

They collect molecules of such chemicals as chlorine and bromine, and as the sun comes up during spring these chemicals react with sunlight and cause ozone depletion.

What is surprising here is that these clouds are hardly ever seen this late, Dr. Carlson said.

It may be that there is a feedback effect that goes on because as these things destroy ozone there is less ozone in the stratosphere. Ozone heats up the stratosphere, with less ozone there is less heating. "It gets colder, and as it gets colder more clouds form, destroying more ozone and the cycle goes on," he said.

All the photographs *Galileo* took of earth were of the planet's northern hemisphere in the dark as it passed by. They mainly show details of Antarctica, Australia and South America.

Galileo, launched from the space shuttle Atlantis in October 1989, is the first to return to earth's vicinity after visiting Venus. The space probe soared around in December in a slingshot effect to boost its orbital speed around the sun.

It will receive another earth-boost in December 1992 to send it on its way to its eventual destination, Jupiter, which it is expected to reach in 1995. *Galileo's* next celestial encounter will be with the asteroid Gaspar in October. It will fly within 1,600 km of it in the first meeting between a man-made space probe and an asteroid.

Cold Treatment for Arthritis

German doctors have found a new treatment for the hot, inflamed joints stricken with arthritis. The treatment called cryotherapy or cold therapy, offers relief in rheumatoid arthritis, ankylosing spondylitis, osteoarthrosia and low backache, claims Dr. Reinhard Frickee.

Presenting his views on the second day of the four-day international conference on physical medicine and rehabilitation in Delhi, Dr. Frickee said that in the cold therapy ice or cold air is used at minus thirty degrees Celsius or nitrogen gas is used at temperatures ranging between minus 160 degrees and minus 180 degrees.

Dr. Frickee said if the disease is limited to a particular joint, localized cold therapy is performed. If the disease is generalized, the patient is treated inside a special chamber, provided he can afford the tremendous cost of the treatment. The special chamber treatment costs more than Rs 12 million.

Dr. Frickee said only patients with atherosclerotic disease of blood vessels cannot be helped by cold therapy. Otherwise, the treatment is free from risks and people of all ages, and either sex, can benefit from it.

"Liposome" Missile for Drug Delivery

Biochemists of Delhi University have developed a chemical version of guided missile that can carry in its "warhead" drugs for delivery to specific target inside the body, the last Science Congress session held at Indore was told.

The missile called "liposome" is nothing but a tiny spherical capsule of bio-degradable fat entrapping on the "cargo" which can be a drug for treatment of a disease, or a protein or even a gene destined for delivery to a particular type of cell.

Prof. B.K. Bachhawat, chief biochemist of Delhi University South Campus, told the Congress that liposome missiles had successfully been used in his laboratory for targeting drugs directly to a specific type liver cells in rats. In another experiment, the missiles were successfully used to target the anti-fungal drug AMP-B to specific cells inside mice to treat "aspergillosis" in mice.

Aspergillosis is a common fungal infection among patients with poor immunity such as those suffering from tuberculosis and cancer. AMP-B is the only accepted therapy to treat the fungal infection, but this drug is extremely toxic and produces side-effects.

Prof. Bachhawat said by entrapping the drug inside the liposome missiles, low doses can be used and side-effects eliminated.

Prof Bachhawat said, in his experiments on animals, the fungal infection was treated by a single dose of AMP-B carried by the missile. Liposome missiles can also be used in immunology. His laboratory has made a successful attempt to elicit antibodies to the hormone "estradiol" using specially made liposome missiles.

A major advantage of liposome technology in immunology is that the entrapped antigen is not exposed to micro-circulation and is thus protected from the degradation by circulating enzymes. Liposome also acts as a depot for the antigen and allows the slow release of antigen rendering it more immunogenetic, he said.

Biological Control of Pests

A farmer from Tamil Nadu has successfully field-tested biological control of pests in crops by mass culturing a beneficial parasite that attacks and destroys the virulent internode borer pest affecting sugarcane.

The farmer, Mr. N. Rajendran, had received the initial training and the knowhow from scientists of the Tamil Nadu G.D. Naidu Agricultural University on culturing the trichogramma parasite. He has taken up mass culturing of the parasite in his tiny laboratory in Chittar village, about 30 km from Bhavani town, known for large-scale sugarcane cultivation. He supplies the cultured parasite eggs which eat away the eggs of borer pests in sugarcane.

The farmer produces on an average 120 cubic centimetres of trichogramma parasite eggs a day. The volume of one cc roughly contains 18,000 to 20,000 parasite eggs. The parasite eggs are reared out of the eggs of the corcyra moths and the harvested corcyra eggs in the laboratory are glued with paste on paper cards measured in one cc column spaces and enclosed in polythene wrappers. The eggs are then exposed to be afflicted by the trichogramma parasite which occurs naturally in about three to four days.

The parasite eggs are later distributed to the farmers and cane growers with the paper cards to be planted in their fields. On maturity, the insects emerging from the eggs spread all over the field and settle. The multiplying beneficial insects attack the eggs of the borer pests in the cane, thus offering biologically barrier to this important sugarcane pest.

The farmers in the area and the farm scientists at Coimbatore and elsewhere testified that the trichogramma parasite induced corcyra eggs have proved quite effective in drastically bringing down the internode borer pest population in sugarcane crop completely obviating the use of chemical spray.

The scientists said the laboratory trials carried out at the university had proved that the parasites could effectively control over the dreaded *Haeliothis* in cotton and white fly in rice.

Conversion of Natural Gas by NCL

An Indian laboratory has succeeded in developing a novel system that can convert natural gas into kerosene and diesel. The achievement of the Pune based National Chemical Laboratory is considered significant in view of the fact that this is a highly competitive area which is protected by giant multinationals.

Given the situation in the Gulf and the fast depletion of oil reserves, natural gas has a vast potential for the production of kerosene and diesel. At present, imported crude oil is the main source for these middle distillates.

Starting from early 1985, NCL has been working on the development of a suitable catalyst for conversion of the light olefins to middle distillates. A patent has now been granted to NCL in the USA for this major achievement. The overall process of converting natural gas to middle distillates consists of three stages. The first stage is conversion of natural gas to syngas, the second is production of olefins from syngas, and the third stage is the production of middle distillates from olefins.

The stages one and two in the overall process have already been completely at the "bench scale level" by NCL in collaboration with Davy McKee of Britain, one of the largest project engineering companies in the world with special expertise in natural gas processing. A pilot plant, to try the third stage, is expected to be ready by the end of 1992 which will be run for about a year to generate the design data. The commercial plant can be expected to be in operation by the end of the decade.

The most important features of the NCL process are: It can use feedstocks such as the refinery streams like FCC of gas, coal gasification products and crude methanol from renewable sources; product flexibility can be varied to get a wide range of kerosene to diesel ratios from 20% to 80% and other important intermediates like propylene.

India has already large natural gas reserves and the probability of finding gas reserves is estimated to be brighter than finding new oil reserves.

Research on Diabetes Gene

A breakthrough that may produce new ways to treat and prevent the most common form of diabetes was reported by medical researchers. The University of Chicago said the general location of the gene that appears to cause one form of the disease was identified in a particular area of a specific chromosome.

"This finding confirms, first of all that genetics play a role in the development of diabetes." said Dr. Greame Bell, a professor of medicine at the school. While the gene itself has not been isolated, "we now know where to look," he said.

The gene is believed to cause one form of non-insulin-dependent diabetes mellitus, sometimes called adult-onset diabetes. The disease, usually controlled by diet and exercise or oral medication rather than insulin injections, affects 12 million people in the USA and is the most common form of diabetes, says the American Diabetes Association.

The hunt for the gene was conducted by researchers from the universities of Michigan, Pennsylvania and Chicago. The study was published in the proceedings of the National Academy of Sciences.

The investigation was possible because of research by Mr. Stefan Fajans of the University of Michigan, who spent 32 years studying a single family with 275 members spanning five generations. More than 40 family members had mature-onset diabetes. "This is the first family in which genetic techniques have been used to identify a genetic abnormality as the cause of diabetes," Dr. Bell said.

While heredity had long been recognized as playing an important role in the disease, it has been difficult to gather large cross-generational families for studies.

Victims of non-insulin-dependent diabetes cannot produce enough insulin or fail to respond to the insulin that is produced by the body. Insufficient insulin prevents cells from absorbing glucose for use as fuel.

Potential Applications of Hypermedia Systems in Chemistry Education

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Hypermedia systems offer excellent tools for tailoring learning to the needs of the individual learner Hypermedia provide "enabling" rather than "directive" environment, offering more learner control over the learning process.

Introduction

This paper will survey the potential applications of hypermedia systems in chemistry education According to Halasz[1] hypermedia systems represent "a style of building systems for information representation and management around a network of multi-media nodes connected together by typed links" (p. 836). Hypermedia systems can be viewed as "databases modeling node-link networks"[2]. Nodes are "typed texts" or "graphics" corresponding to a "window on the monitor screen" and links are "highlighted texts or icons in the window"[1,2] which interconnect different nodes. Links are activated by a mouse and can be utilized to activate simulations and interactive videos[2].

Hypermedia systems can be designed in various configurations. Usually they include computer software such as the "hypercard" (by the Apple Computers) or "hyperpad" (by IBM), interactive videos, interfacing hardware, and interlinkage with large computer networks The software hypercard and hyperpad offer opportunities to create stacks of electronic cards on topics of the designer's interest, and interlink the cards using buttons and icons. The cards can also be easily programmed to interact with video players, access large library data bases and even to control laboratory instruments.

Potential Applications in Chemistry Education

The potential applications of hypermedia systems in chemistry education have not been fully explored. As a computer-based instructional technique, hypermedia systems could make chemistry more meaningful to the learner[3]. Hypermedia systems can be used in chemistry instruction to.

- create a new learning environment
- present text materials in different ways
- structure learning to the individual needs of the learner
- provide intellectual tools for instruction
- stimulate inquiry learning
- guide laboratory experiments
- remove spatial and temporal constraints
- provide feedback, and
- bridge chemistry, technology and society.

The following discussion elaborates the potential applications of hypermedia systems listed above. There are various ways hypermedia systems could be designed and developed in order to meet the needs of the learner.

Create a New Learning Environment

Hypermedia systems can be designed as an electronic library[4]. Hypermedia have been suggested as a tool for storing and distributing the world's entire scientific and literary information[5]. This application of the hypermedia can add a new dimension to the traditional classroom environment, enabling the learner to handle limitless information at fingertip. For example, in teaching chemical concepts which require background knowledge, hypermedia systems can be very useful for reviewing. The learner can trace back the meaning and definition of the concepts under study with flexibility, and avoid memorizing chemical information There are several advantages of the hypermedia as a library system[6,7]:

a. ease of tracing references where all references are equally accessible to follow forward to their referent, or backward to their reference
b. learners can grow their own information networks
c. both hierarchical and non-hierarchical organizations can be imposed on unstructured information
d text segments can be threaded together in different ways, allowing the same document to serve multiple purpose
e. convenience in referencing the same text segment from several places, allowing ideas to be expressed with less overlap and duplication
f. consistency of information even if the text is moved to another topic because the link still provides direct access to the reference.

Present Text-materials in Different Ways

Hypermedia applications in chemistry education can replace traditional textbooks with mor student-centred computer textbooks. Textbook publishers are already finding ways to fully utilize hypermedia systems for presenting text materials with more flexibility[9]. For example, graphic representations of electronic configuration o atoms can be arranged in various ways using hypermedia systems so that the learner has acces to visual examples of every particular detail about the topic. With additional programming hypermedia systems can be linked to interactiv videos of simulations showing how electrons ar placed around the nucleus in the order of increasing energy and decreasing stability. Otherwis such concepts of energy levels associated wit electronic configuration will demand more tim and manual referencing for a meaningful understanding.

Structure Learning to the Needs of the Learner

Hypermedia systems offer excellent tools for tailoring learning to the needs of the individual learner. Hypermedia provide "enabling" rather than a "directive" environment, offering mor learner control over the learning process[3]. Some students are fast learners while other are not. Slow learners need more time for understanding and comprehending difficult chemical concepts. For example, using a hypermedia system on chemical kinetics, linked to a video, the learner can control the reaction speed and explore the reaction pathway. Thus, a slow learner has options to control the pace of learning about reaction kinetic.

Provide Intellectual Tools for Instruction

Hypermedia systems have much in common with the current conceptions of learning based upon cognitive psychology[9]. According to cognitive psychology, learning is a reorganization of knowledge structure[10,11,12] The knowledge structure refers to the organization of information in semantic memory, often known as "schema". A schema for any object, idea or event consists of a group of attributes. For example, the schema for hydrogen atom is comprised of attributes such as spherical, s-orbital, electron cloud and things which contain hydrogen atoms such as acids, water, etc. Each schema as a mini-framework can be represented by a card in a hypercard stack.

Stimulate Inquiry Learning

McAleese[13] has presented an argument for using the navigational aspect of "notecard" for knowledge acquisition and exploration. Notecard is a hypermedia software similar to the hypercard. For example, teachers can design lessons on chemical bonding in a hypermedia system. To stimulate inquiry, thought provoking questions can be included in the text. However, this application of the hypermedia systems needs more careful planning and design for better learning outcomes.

Guide Laboratory Experiments

Teachers can use a hypermedia system as a guiding medium for laboratory experiments. Russel, Moran & Jordan[14] augmented notecards as a delivery vehicle for computer assisted instruction. Teachers can design laboratory procedures in the form of flow charts for students to follow in chemical experiments which require careful planning. A visual image of a procedure in front of the learner is easier to follow through than reading printed notes[4]. However, teachers should not misunderstand this use of the hypermedia as an excuse for not directly participating in chemistry laboratory activities

Remove Spatial and Temporal Constraints

Even though hypermedia systems are not directly designed for simulations, they can be used for steering interactive video simulations[3,4]. For example, in teaching about mole ratios it is difficult to conceptualize how one mole of oxygen and two moles of hydrogen combine to form two moles of water. Through hypermedia stacks linked to interactive videos of simulated chemical reactions, the learner can see how three moles of reactants become two moles of products.

Provide Feedback

Hypermedia systems are useful for providing formative feedback to the learner. For example, the stack nature of the hypercard provides room for constructing test questions based on Blooms's[15] taxonomy. Cards can be set up to enable the learner to master a topic at a particular cognitive level before proceeding to the next higher level. Chemistry tests can be designed to test the learner's understanding of the electronic configuration of p-orbitals before moving to d-orbitals.

Bridge Chemistry, Technology and Society

One of the objectives of science education should be to equip students to be more aware of the role of science and technology in every aspect of human life, and to enable them to address societal issues stemming from science[16]. In this context, hypermedia systems offer limitless opportunities to link chemistry, technology and society. The browsing and navigational facilities associated with hypermedia systems can be fully explored to design learning materials which present a multi-dimensional view of chemistry.

For example, acid rain is a chemical topic of societal importance. With the hypermedia, it is possible to present newspaper clippings, expert opinions, court decisions and pictures of global areas affected by acid rain to the students in order to initiate discussion. As in any scientific application, there are advantages and disadvantages of hypermedia systems. Apart from the potential applications of hypermedia in chemistry education discussed so far, there are some possible disadvantages.

Anticipated Disadvantages

Unstructured hypermedia applications in chemistry instruction can be detrimental to learning. Some of the anticipated disadvantages are[8,12,17,18,19]:

- getting lost in navigation through an unstructured hypermedia system
- lack of access structures necessary to guide the user
- cognitive stagnation due to the exponentially large number of learning options available to the learner
- lack of sufficient teacher training in designing and preparing hypermedia systems for instruction
- disorientation due to non-linear documentation
- copyright concern when networking with large library databases
- cost and difficulty of creating hypermedia software which are not mere electronic page turners.

Conclusion

Potential advantages of the hypermedia systems in chemistry education are many, ranging from cognitive to affective aspects of learning. Also, there are some anticipated disadvantages resulting from unstructured design and unplanned implementation of this technology. Nevertheless, there is indeed every reason to be excited about the prospects of using hypermedia systems as a basic educational technology in chemistry education. Applying hypermedia in education is like immersing one's brain into a sea of information and handling those information with freedom and flexibility[6]. This notion of hypermedia system corresponds to the notion of perpetual objects where one can manipulate thoughts, ideas and their relationships through buttons on the computer screen[6]. The use of hypermedia in conjunction with recent developments in animation, three dimensional colour monitors and interactive videos offers hope for meaningful chemistry learning. As Vannevar Bush[20] said, the hypermedia systems should be viewed as "the first step towards the age when the personal computer will be a direct and powerful extension of the human mind". Applying hypermedia systems in chemistry education will make chemistry learning more enjoyable and realistic.

Acknowledgement

I would like to thank Mr. Mark Hedrick, Bill Wilkerson Center, Vanderbilt University for critiquing an earlier draft of this paper.

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Improving Science Curriculum

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Science for students should be interesting. Dull routine activities need to be eliminated. The methods and content of science need to be emphasized in each lesson and unit of study. Each student needs to achieve optimally in ongoing lessons and units

The science teacher needs to utilize a variety of learning activities to provide for individual differences among students. The less talented as well as gifted students need to achieve optimally in ongoing lessons and units. Providing a variety of science activities for learners also has as a goal to provide for diverse styles of learning. Students learn in different ways, such as achieving more from selected kinds of activities, as compared to other experiences, be that concrete, semiconcrete, or abstract experiences. Within each of these — the concrete, the semiconcrete, or the abstract — diversity of activities is also possible. For example, with concrete materials, the following are possibilities to utilize in teaching: seeing actual plants in the classroom, observing plants on the school grounds or city park, making model plants, and seeding/growing selected plants. The semiconcrete may emphasize the use of filmstrips, slides, films, drawings, pictures, transparencies, and study prints of different plants. Abstract learnings may emphasize reading, discussing, listening, and writing to learn about plant life.

With the use of concrete, semiconcrete, and abstract facets of teaching, principles of learning taken from the fields of educational psychology stress that students

1. take interest in learning
2. attach meaning to what is being learned
3. achieve purpose in ongoing lessons and units
4. sense knowledge as being related, not isolated fragments.

Learning Activities in Science

Activities for students assist in attaining carefully selected goals. Diverse learning opportunities for specific units of study in science will now be discussed.

If a unit on "A Clean Environment" is being taught, students with teacher guidance may pick up litter on and near the school grounds. The collected litter may be classified as being biodegradable as well as non-biodegradable. Ways of controlling and preventing pollution should be discussed. Posters may be developed by students individually or in committees to convey information on the necessity of developing and maintaining a healthy, aesthetically pleasing environment. In a related activity, students may draw a map of the school grounds.

In a science unit on "Weather and How It Affects Us", students may record the temperature reading each hour. It may be necessary to have an alarm clock in the classroom A bar or line graph should be drawn to show hourly temperature readings

If a science unit on "Plants in Our Community" is being emphasized, students with teacher direction may in early spring measure the amount of growth of twigs at selected intervals of time Students can make drawings of and identify selected twigs Relevant subject matter may be gathered, from a variety of reference sources, to understand principles of science involved as to why twigs grow. Leaf scars, lenticels, and buds, among other concepts, may be studied.

Units of study on "Insects in the Community" may capture the interest of many students. Selected insects may be collected and placed in a plastic vial. Diverse parts of insects need classification, such as the head, thorax, and abdomen. The digestive system of these insects can be studied. Students may sketch the insects and release them when finished. Excursions on and near the school grounds may be conducted to observe and identify insects in the local community.

In a unit on "The Pond Community", students with teacher guidance may observe animal tracks on the pond area. Sounds of animals need to be noticed. Direct observation of plant and animal life is important. Smells in the pond community need to be noticed by students. Students need to record that which the senses experienced. The mechanics of writing (correct spelling, punctuation, and agreement of subject and predicate) may also be stressed.

To extend learnings acquired, students may write diverse forms of poetry on the pond community Students should select which kind of poetry to write whether it be haiku, tanka, quatrains, cuplets, triplets, diamantes, or free verse.

A jar of pond water should be taken along from the excursion Animal life in the jar needs to be studied over a period of time. Additional contents, such as mud, leaves, and twigs in the jar should also be studied.

In studying a unit on "Nutrition and How It Affects Us", students may study the specific parts of a garden plant that is eaten. Pictures can be collected and drawn pertaining to common garden crops. Learners might then learn to classify if

(a) the seed part is eaten (sweet corn, peas, and green beans).

(b) the stalk is eaten (celery and rhubarb).

(c) the roots are eaten (onions, radishes, carrots and potatoes).

(d) the leaves are eaten (lettuce and spinach).

(e) the fruit is eaten (strawberries, apples, pears).

Magnifying glasses should be present in the classroom for students to observe seeds, stalks, roots, leaves and the fruit parts of a plant.

When initiating a unit on "Rocks and Their Uses", the teacher may display igneous, metamorphic, and sedimentary rocks at an interest centre. Students may view slides, filmstrips, and pictures on these three kinds of rocks. For homework, students should locate as many examples of igneous, metamorphic, and sedimentary rocks as possible. An individual, committee, or class as a whole collection of rocks can be an end-result in the ongoing unit of study. Learners also need to research the diverse uses of rocks.

When studying a unit on "Conservation of Natural Resources", students with teacher guidance need to analyze causes for soil erosion on the school grounds or nearby areas. A problem needs solving here in terms of remedying eroded area(s).

For enrichment experiences, students may

1. write any word that starts with the letter A and for each letter of the alphabet. What is recorded must have been experienced through the use of the senses.
2. divide into groups and find one item of each of the following: a seed, a feather, a twig, a rock, a beetle, a nut, a frog or toad, a flower, a catepillar, and a fern.

In Summary

Science for students should be interesting. Dull routine activities need to be eliminated. The methods and content of science need to be emphasized in each lesson and unit of study. Each student needs to achieve optimally in ongoing lessons and units.

Computing 1: Comparative Studies of Some Important Computer Languages

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The chapter on 'Computing' introduced for the first time in the Mathematics Syllabus of NCERT at the Secondary and Senior Secondary levels is considered a very 'difficult' topic by most of the mathematics teachers. This topic has become difficult not merely because it is completely new for them, but also because most of the mathematics teachers are not familiar with the logic, grammar and the restrictions involved in various control statements used in different computer languages. The chapter on computing as presented in the mathematics textbooks does not discuss a particular computer language, but a pseudo language in which different control statements have been borrowed from different computer languages. Hence, this topic as presented in the mathematics textbooks is strictly speaking neither a topic of Computer Science nor a topic of Mathematics A person of Computer Science with a little mathematical background can easily understand this pseudo language, but it is really difficult for a mathematics teacher having no background of any computer language to teach this chapter to the entire satisfaction of the students. In order to simplify this 'difficult' topic to a mathematics teacher, the author who has many years' experience of preparing computer programmes of difficult mathematical problems in several international computer languages will first discuss briefly in a series of such articles the functions and restrictions of some important statements used in some well-known computer languages, and then discuss the algorithm in pseudo languages and draw flow diagrams for various types of mathematical problems.

Introduction

In this article, we shall mainly consider three well-known computer languages, viz , FORTRAN IV, KDF9 ALGOL and BASIC. Although there are latest versions of FORTRAN IV and other languages, the reasons for choosing these three languages mainly are (i) most of the control statements and logic in a pseudo language, the discussion of which is our main objective, can be borrowed from these three languages and (ii) we want to avoid unnecessary complications by discussing various statements in other computer languages.

Fortran is an acronym for FORmula TRANSlation or FORmula TRANslator. This language like other languages is not directly understandable to the computer. It has to be changed into machine language by a machine language programme called compiler or processor. The

Fortran instructions duly translated by a compiler may be executed by any computer.

Fortran is widely used for various problems of Science and Engineering. John W. Backus, an IBM Engineer, first used it in 1954 on IBM 704 computer A new version, Fortran II was released by IBM in 1958. This was further developed and many powerful features were introduced and Fortran IV was released in 1962. The latest version of Fortran language is known as FORTRAN 77.

ALGOL is an acronym for ALGOrithmic Language. It has been accepted as a common international language for use with algebraic problems. ALGOL's inherent merit is the basis of its widening acceptance for both scientific and engineering applications. The power of its statements often surprises new-comers. Its conciseness avoids much of the tedium in other forms of programming, simplifies the programming of complex problems, and makes it an acceptable medium for solving the occasional problem. The use of conventional symbols of mathematics and the borrowing of ordinary English words to form ALGOL symbols helps to make an ALGOL programme easy to read and understand.

There are various types of ALGOL programmes such as ALGOL 60, KDF9 ALGOL, etc. KDF9 ALGOL is a proper subset of ALGOL 60 and had been developed by English Electric — Leo Computers Ltd., Kidsgrove, Stoke-on-Trent and Staffordshire.

BASIC is the easiest of all the programming languages. Its full name is "Beginners' All-purpose Symbolic Instruction Code". Yet this simple language is very powerful and versatile having a wide variety of applications. Consequently, BASIC programming courses have now been introduced in many schools of our country. At present BASIC has become the standard language for most microcomputer applications. There are two types of BASIC: 'Basic BASIC' and 'Advanced BASIC'. The former deals with the commonly used features of the language and the latter is concerned with more specialized features like subroutines, matrix statements and file manipulation.

BASIC was originally developed at Dartmouth College by John Kemeny and Thomas Kurtz in mid 1960s. Later on, BASIC rapidly became the most popular and widely used time-sharing language in the USA. There is some variation in the different versions of BASIC that are currently available.

In this article, we shall study briefly the main features of these three languages with special emphasis on important control statements which will be used later in writing algorithms of a mathematical problem using a pseudo language.

Use of an Integer, a Decimal Number and a Variable

In all the three languages, an integer is used such that it may contain at least one digit without any decimal point. It may have either A+ sign or a– sign or it may be an unsigned number. An unsigned number will be treated as positive.

In Fortran IV and Basic, a decimal number must have at least one digit and must be written with a decimal point. It may have either the + or the – sign or no sign at all preceding it. Thus 10., –.57, +0.53 etc. are all valid statements. In KDF9 Algol the same rule is true with the exception that after the decimal point there must be at least one digit. Thus 10. is not allowed in KDF9 Algol; it should be written as 10.0.

A real constant can be written in the exponent form which consists of a mantissa and an exponent. The mantissa must have at least one digit and a decimal point in the case of Fortran IV and Basic, but this is not necessary in the case of KDF9 Algol. The mantissa is followed by the letter 'E' in the case of Fortran IV and Basic and by the subscript 10 in the case of KDF9 Algol.

The exponent must be an integer and must have at least one digit in the case of all the three languages. A sign for the exponent is optional. In the case of KDF9 Algol, the mantissa may be omitted, while if the subscript 10 appears, the integer exponent must not be omitted.

The various numbers which can be written in three languages are shown below:

Mathematical numbers	0	6	−7.3	.65	74	$-.7 \times 10^5$	10^{-15}
KDF9 ALGOL	0	+6	−7.3	+.65	74.0	$-.7\ 10^5$	10^{-15}
FORTRAN IV and BASIC	0.	+6	−7.3	+.65	74.	− 7E5	1.E−15

In pseudo language, we shall write these numbers like those which we use in Mathematics.

All variables or identifiers used in all the three languages may be single letters of the English alphabet or sequence of letters and numbers. The first symbol of a sequence must be a letter. In KDF9 Algol, the English letters may be either in upper or in lower case, but in Fortran IV and Basic, no English letter in lower case is used.

In Fortran IV, if a variable represents an integer, then the first letter of the integer variable name must be I,J,K,L,M or N unless we declare them otherwise.

In KDF9 Algol or Basic, there is no such restriction. But in KDF9 Algol, we must declare at the beginning of the programme whether the variables used are real or integer. In Basic, the declaration of the variables as real or integer is not necessary. In Fortran IV, we may, if we like, declare the variables. Suppose we want to declare the variables 'Count', 'big', 'num' as real and 'Delta', 'T1', 'J_2' as integers. This can be done in the following way:

```
Fortran IV:    REAL COUNT, BIG, NUM

               INTEGER DELTA, T1 J2

KDF9 Algol:    Real Count, big, num

               Integer delta, T1, J2
```

Note that in KDF9 Algol, the words 'Real', 'Integer' must be underlined The different variable names must be separated by commas and there will be no full stop at the end. All such statements should be written one below the other. In a pseudo language, we shall not declare these variables at all like in Basic.

Use of Arithmetical Expressions

In writing an arithmetical expression, we have to use variable names and five mathematical operations, viz., addition, subtraction, multiplication, division and exponentiation. The symbols used for these operations in the three languages are given below:

Use in KDF9 Algol	Use in Fortran IV	Use in Basic	Mathematical operation
+	+	+	Addition
–	–	–	Subtraction
x	*	*	Multiplication
/,+	/	/	Division
↑	**	↑	Exponentiation

Note that there is a slight difference between the symbols / and + used in KDF9 Algol. The former operation produces a result of type real whereas the latter produces a result of type integer. The former symbol can be used with combination of any type of numbers, real or integer or both, but the latter symbol should be used only between two integers. If the result of some operation involving real type numbers happens to have an integer value, its type is not thereby changed from real to integer in KDF9 Algol. In terms of the internal working of the computer, though the result happens to be an integer, it is still in floating-point form The result of exponentiation is of the same type as the base, if the exponent is an integer and +ve or zero, otherwise the result is real.

Note that 3 + 2 will be in integer form and so the computer will give the result as 1 and not 1.5 which is the correct result. In order to get the correct result, we should write it as 3/2.

In some problem when it is required to calculate the integer part of say $\frac{m}{n}$, where m,n are positive integers, we need to write it as m + n.

Mixing of a real number with an integer in an operation in Fortran IV is not allowed. In Fortran IV, 3/2 will produce integer result, viz., 1. Since here only one symbol is used for division, in case we want the correct result, we should write it in the form of division of real numbers. Thus 3/2 will produce the exact result 1.5 which is a real number.

In Basic there is no such restriction at all. We shall use * for multiplication, and exponentiation will be expressed as in mathematics while writing algorithm using pseudo language. Thus $a^2 + cd - x$ will be written as $A^2 + C*D - X$ in a pseudo language.

We now give some examples of arithmetical expressions and write them in different languages:

EX. 1 $\frac{a^x + b}{x^a - b}$

EX.2 $(4x^2 + 3y^3)(3y + 2z - 4)$

EX.3 $1 - x + (x^2)^2/2 - (x^3)^2/6 + 5.8(x/y + 2z^2)$

In KDF9 Algol

1. $(a \uparrow x + b) / (x \uparrow a - b)$
2. $(4 \times x \uparrow 2 + 3 \times y \uparrow 3) \times (3 \times y + 2 \times Z - 4)$
3. $1 - x + x \uparrow 2 \uparrow 2 - x \uparrow (3 \uparrow 2)$
   $+ 5.8 \times (x / y + 2 \times Z \uparrow 2)$

In Fortran IV:

1. $(A ** X + B) / (X ** A - B)$
2. $(4.0 * X ** 2 + 3.0 * Y ** 3)$
   $* (3.0 * Y + 2.0 * Z - 4.0)$
3. $1.0 - X + X ** 2 ** 2 / 2 - X ** (3 ** 2) / 6$
   $+ 5.8 * (X / Y + 2.0 * Z ** 2)$

In Basic

1. $A \uparrow X + B) / (X \uparrow A - B)$
2. $(A * X \uparrow 2 + 3 * Y \uparrow 3)$
   $* (3 * Y + 2 * Z - 4)$
3. $1 - X + X \uparrow 2 \uparrow 2 / 2 - X \uparrow$
   $(3 \uparrow 2) / 6 + 5.8 * (X / Y + 2 * Z \uparrow 2)$

In a Pseudo Language

1. $(A^x + B) / (X^a - b)$
2. $(4 * X^2 + 3 * Y^3) * (3 * Y + 2 * Z - 4)$
3. $1 - X + (x^2)^2 / 2 - (X^3)^2 / 6$
   $+ 5.8 * (X / Y - 2 * Z^2)$

Note that all expressions are evaluated by a computer from left to right. All the exponentiations are done first. If more than one exponentiation exists successively without any bracket, then all the exponentiations will be evaluated successively from left to right. After the completion of exponentiations, the expression is examined again from left to right. Now all divisions and multiplications are evaluated. If a number of divisions and multiplications exist successively, then the calculation will be made from left to right. Finally, all the additions and subtractions are done starting again from the left of the expression.

Errors and Significant Figures of an Observation: Their Implications for Practical Work in Physics

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It has been observed that there is some confusion about the concept of significant figures of an observation and criteria for deciding about the digit to which a result should be rounded off. Three different views seem to exist in different books and in school teaching, out of which the author selects one which he considers correct and presents the arguments therefor. He also throws light on a laboratory procedure which is directly related to this concept, viz., the observation of the reading on a scale.

Various Meanings of the Phrase 'Significant Figures'

The Physics Textbook for Class XI[6] explains the concept of "significant figures" of a reading as under:

"It indicates the extent to which the readings are reliable. It is normally those digits in (a measured value of) a quantity that are known reliably plus the first digit that is uncertain."

The Chemistry Textbook for Class XI[7] seems to give a different concept and so it was pointed out to the author by participants of the orientation course held at K.V., I.I.T., Kharagpur. According to it significant figures include those digits which are known reliably plus the first uncertain digit. It further clarifies that the uncertainty in the uncertain digit is taken as ±1. However, there is a certain ambiguity and imcompleteness involved in this concept. Consider the following example:

In measuring a certain velocity one gets a result = 198615 km/s and the uncertainty in it (say, the standard error) is ±320 km/s. Then the first uncertain digit is 6, which is the fourth digit. Because the uncertainty in the fourth digit is more than ±1, one would like to round it off to 3 digits as 1.99×10^5 km/s and say that it has 3 significant figures, according to the above concept. But in doing so, the process of rounding off introduces an error of 4 in the fourth digit, which is greater than the uncertainty in the result. Thus you are throwing away to dust-bin the precision of which your experiment is capable, and hence the ambiguity and the incompleteness of the above concept.

The author has been told by teachers in various orientation courses and seminars that a third concept of significant figures is being presently taught in schools, viz., "the number of digits known reliably". Thus the uncertainty in the last digit retained, in a result should not exceed half. This concept would, obviously, compel one to introduce even larger error by the process of rounding off in certain cases than the concept described in the Chemistry textbook published by the NCERT.

The Case of Experiment on Length Measurement

To understand the implication of above arguments for practical work in physics, consider the simplest experiment, viz., measuring the length of a given straight line or a needle with the help of a metre scale. In a reading, let one end of the needle be at the mark 6.0 cm and the other between15 4 cm and 15.5 cm, being closer to the 15.5 cm mark. All the teachers present in the orientation course held at I.I.T. Kharagpur*, where this example was discussed, reported that according to present teaching practice the upper reading will be given as 15.5 cm and length of the needle as 10.5 cm. Thus the student is allowed to take reading to the nearest scale division marked on the scale. He is not allowed to make an estimate of the fraction of the smallest division and make a reading, like 15.46 cm. Reasons for this practice were stated to be the following two opinions:

1. Science is objective. There is no room for guess work in it and hence the student is not allowed to guess the fraction of a millimetre, which is the smallest division on the scale. One must write only reliable digits in one's measurement.
2. Least count of a scale is considered to be a good estimate of the error in the readings taken by it, and the least count of a scale is the smallest division marked on it.

It may be noted that this method of taking a reading is quite in accordance with the third concept of significant figures discussed above.

The Correct Meaning of the Phrase "Significant Figures"

In the opinion of the author the correct concept is the one described in Physics Textbook. No mention of permitted uncertainty in the uncertain digit is to be interpreted as between 1 and 9. If the uncertainty is more than 9, then the digit previous to it becomes the uncertain digit. If the uncertainty is less than 1, then the digit next to it becomes the uncertain digit. Consider, again the example of the velocity 198615 km/s with an uncertainty of ±320 km/s.

The number of significant figures in this reading be taken as 4. On rounding off, this reading will become 198600 km/s, or 1.986×10^5 km/s. In the former manner of writing this result, one is likely to confuse that the 6th digit, zero, is the uncertain digit. Thus the latter format of writing it is superior, and is sometimes called "the scientific notation". In this format one would retain the two zeros after the digit 6 if and only if the 6th digit is uncertain and the 5th and 6th digits obtained by the measurement are zeros.

Implication of this viewpoint for practical work in physics is that while observing a reading on a scale, judgement is exercised in estimating the fraction of the smallest division marked on the scale. The one last digit in the reading so obtained is the uncertain digit, being merely a subjective estimation.

It is noteworthy that, if freedom is allowed for judgement of fraction of the smallest division, then significantly greater accuracy of observation is achieved than in case when this freedom is not allowed. The following experiment was done with the group of teachers, present in the course held at I.I.T., Kharagpur. With the help of a demonistration vernier, length of an object was measured. The vernier scale was suppressed and the teachers were asked to make an estimate of the fractional part of main scale division to be added to the main scale reading (Fig. 1). Then the vernier coincidence was shown, and each and every teacher was found to have made correct estimation. In a similar experiment earlier, the author had a batch of about forty students. In the first attempt errors of various students were within ±0.2 of smallest scale division. A few, by chance, got no error. After four or five such attempts students attained practice in this estima-

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* This enrichment-cum-orientation course in teaching of Physics at Class XI for key persons of North-Eastern region was organised by the D E S.M., N.C.E.R.T at Kendriya Vidyalaya, I.I.T., Kharagpur from 2 to 11 March, 1991

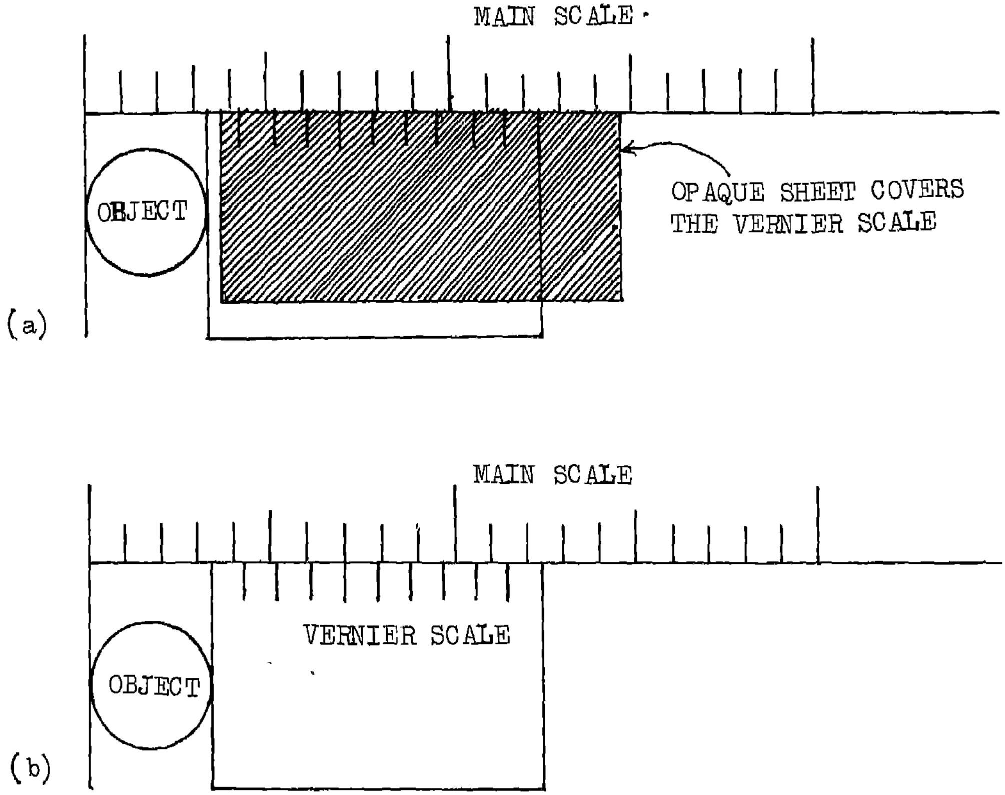

Fig. 1 *A demonstration type vernier callipers can be used to give practice in estimation of fraction of smallest division on a scale, (a) Let students estimate with vernier scale suppressed, (b) Then, let them verify their estimate by the vernier reading*

tion. The error of many more students was zero, and only 2 or 3 had error of ±0.2.

It is thus clear that, if the scale is good and students have the practice of this estimation, then it should be allowed According to Indian standard specifications for a metre scale[8], the accumulated error in the distance between any two marks over any 10 cm length should not exceed ±0.25 mm, and over the entire length ±0 5 mm According to author's experience the statistical probable error in ISI marked scales available commercially, is about 0.1 mm[3]. On allowing the above mentioned judgement, students can make distance measurements with a standard error between 0 1 mm and 0.2 mm. If this judgement is not allowed, one could introduce an error as much as 0 4 mm in a reading, merely on account of the procedure to observe to the nearest scale division marked on the scale.

Regional College of Education (NCERT), Mysore-570006, published in 1972 "Physics Resource Material for Secondary School Teachers"[1]. It says quite clearly that students should be encouraged to make judgement of the fraction of the smallest division on a scale. Old books on Physics practical work emphasise the same practice[9,10,11,12,13] The same practice existed in school teaching in the past. The author is a personal witness to it as a physics teacher upto 1966, when he left school teaching to joint the NCERT. The same practice prevails in the field of Technology and the student of Technology has to de-learn the opinion (1) mentioned above, which is told to him at school stage. For example, following instruction is given under "Using Meters" in a popular book on Electronic Test Equipments[2].

"If the pointer stops in the space between the marks, as it probably will, estimate the additional increment as closely as you can. For example, in Figure 2.22 the pointer is resting between the two minor divisions that represent 2.3 and 2.4. You can estimate the unmarked increment by mentally dividing the space into halves, and halves of halves, as shown in the inset. Since the pointer is slightly to the right of the first fourth of the minor sub-division, you would estimate this reading to be 2.33".

It is to be noted that reading discussed in the above instruction has three significant figures in which the third digit, 3, is the uncertain digit. This digit represents an estimate of the fraction of smallest division on the scale

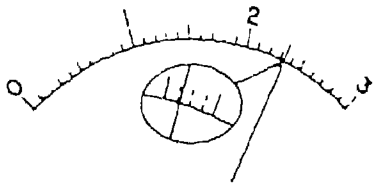

Fig. 2 *Figure 2 22 of reference (2) on reading the scale of an electrical meter*

Why a Wrong Concept and Laboratory Procedure Acquired Popularity?

If the opinions expressed above by the author are the correct concept then a question certainly arises, "How is it that a wrong concept and laboratory procedure of making measurements by a scale has acquired popularity?"

Author's thinking is that unfortunately nowadays one finds poor quality scales flooding the market in which one can quickly find small and large millimetre marks — some even less than ½ mm and some even larger than 1½ mm. Quite frequently one comes across a scale in which accumulated error for a distance of 75.0 cm (measured by an engineers' steel scale) is as much as 0 3 cm. Due to decline in the standards of the industry, teachers/examiners/curriculum developers started feeling that efforts to estimate fractional part of smallest division on a scale are futile and opinions (1) and (2) mentioned earlier gained strength

The author suggests that we accept the fact that estimation is a quite scientific method of measurement if one knows the error involved. Let the academic community not give in to the pressure of industry to produce inferior instruments and legitimatize them by the flimsy argument that because estimation is subjective, it is not allowed in science Let us also accept the fact that least count of an apparatus and precision of the apparatus (i e , the likely error in the reading taken by it) are two different ideas There are metre scales with a precision of ¼ mm and those with a precision of ¼ cm, both having a least count of 1 mm.

The Case of Some Other Experiments

Allowing the above-mentioned estimation (provided the instrument is good) will, obviously, affect many more experiments. For example, in the experiment to study the Newton's Law of cooling one measures temperatures of a body at intervals of 1 minute or 30 seconds, as it cools by radiation. Total cooling in an experiment may be about 15°C or 20°C If smallest division on the thermometer is 1°C and one takes the readings to nearest degree, the error of observation so introduced may make many points representing these readings in the temperature time graph to deviate too much from the smooth curve. If a half degree thermometer is used, the result will be slightly better However, if readings are taken to 0.1°C by estimation and students have the practice of this estimation, then the points will be much closer to the smooth graph and overall precision of the experiment will increase significantly. The use of a half degree thermometer coupled with this estimation will make it almost equivalent to using a ⅒ degree thermometer.

In measuring volume by a graduated cylinder or burette, we usually take an amount of a liquid that the liquid level coincides with a mark on the scale. However, if in some experiment the level happens to be between two marks, the use of above stated estimation is advisible. Exercising this estimation in all experiments is bound to make some contribution to overall attitude of the students towards practical work also.

Measurement in Advanced Scientific Work

It will be of interest to mention here as to what is the practice in advanced scientific work regarding statement of numerical measurements and results Barford[4] explains it by the following example:

If 100 measurements give values

$$X_n = 17.386,\ s_n = 1.226,\ S_n = 0\ 1226,$$

(Here [illegible] the physical quantity to be measured, X_n is the mean of n measurements, s_n is the standard error of a single measurement, which is sometimes termed as "precision of the apparatus", and S_n is the estimated standard error o the mean) then the relative accuracy of S_n is around 10% In other words the true value of S_n has a roughly 2:1 chance of lying within the interval 0.1226±0 01226. It is clear that the third and fourth figures in S_n (i.e., 2 and 6) are of no practical significance, and that even the second is in some doubt. An adequate summary of the result would be

$$X_n = 17\ 39 \pm 0\ 13$$

where the standard error s_n is given to two figures (rounded off to nearest significant figure *above*), and X_n is adjusted to the same decimal place. In any experiment involving ten or fewer measurements, where the errors are estimated solely from these, there is no point at all in giving the precision of the appratus to more than two significant figures or the standard error of the final result (i.e., mean of the measurements) to more than one figures.

In accordance with above explanation the 1986 recommended values of fundamental physical constants given in the Physics Laboratory Manual for Class XI[5], which were obtained from the National Physical Laboratory, carry two uncertain digits together with a mention of standard error of the result. For example, mass of an electron is given as $9.1093897(54) \times 10^{-31}$ kg. Here 54 is the standard error in the last two digits 97. Thus the statement in the Manual "the number of significant figures in each value is two less than the figures given," should be corrected as "the number of reliable figures in each value is two less than the figures given".

Role of the Board's Examination

While the teachers present in the course held at I.I.T., Kharagpur accepted the suggestion that students should be encouraged and given practice to judge the fractional part of the smallest division on a scale, and should be provided with good instruments to make this procedure meaningful, they mentioned a difficulty to which there exists no answer. They stated that if they ask the students to practise this estimation and then use it in the examination, the external examiners are going to deduct marks instead of crediting such students. No doubt it introduces a subjectivity in assessment of the student's skill, the author would advise examiners to allow this estimation.

Another important issue is that in the examination we attach little importance to accuracy of results obtained by the candidates. Then why bother them to take accurate observations by estimations of fraction of the smallest scale division? The answer is that this estimation is itself one of the skills which are useful and important for a science student. This concession is meant to insure the candidates against such odds as a fault in the apparatus, etc. And, why ask the students to learn a procedure of taking observations and a flimsy logic to support it (that subjective estimation is not allowed in science) only to make them de-learn it at a higher stage?

Acknowledgements

Thanks are due to participants of "Workshop for Production of Instructional Material in Physics for +2 stage (Class XI) for use in Orientation Programmes" held at D.A.V. Public School, Kailash Hills, New Delhi - 110 065 from 19 to 25 March, 1991, for discussing these ideas and making several useful suggestions.

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Life Science Teaching: Why not Make it Livelier?

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Observing a living organism in the class, with the teacher supplementing the details, will not only attract the child and form an imprint of the activity but will also make the child appreciate the creations of nature.

Biology, the study of life, has fascinated man since the development of man's cerebram and the power of thinking. The classification of biology into botany and zoology is really unfortunate, for, plants and animals are extremely interrelated and interact with each other. The study of biology includes cell biology, genetics, physiology, embryology, ecology, evolution, taxonomy, etc. Each aspect of this subject is concerned with life — plants have life, animals have life, and we as animals have life. Such a subject dealing with life unfortunately is knowingly or unknowingly made lifeless in many classrooms due to ill planning and lack of imagination on the part of the teachers handling the study of life.

The first lesson in biology even at the primary level is to make the child aware of the difference between a living organism and a non-living thing. Organisms are a wonderful creation of nature exhibiting a wide diversity of types and patterns, colours and shades. These organisms are inseparably interrelated with the environment Plants and animals — flowers and fruits, birds and butterflies — all add colour to the world of nature. The teacher in the classroom cites dull examples of a cat and/or a dog making students recall whatever knowledge they have of these animals. To please the teacher, the child usually nods affirmatively for the abstract examples cited by the teacher Such abstract examples are not necessary for an intelligent teacher to illustrate the characters distinguishing living organisms. The characters of a living organism can be well illustrated in the class, by the teacher taking a simple harmless living organism to the class. The choice is obviously the earthworm. Earthworms are easy to collect and even easier to maintain in the school.

Earthworms are so simple and harmless that even children of primary classes can be encouraged to handle these animals inside the class in the presence of the teacher Teachers can however caution younger children not to handle any, living organism they come across lest it should hurt the innocent children because some organisms defend themselves, thinking that they are being harmed Observing a living organism in the class, with the teacher supplementing the details will not only attract the child and form an imprint of the activity but will also make the child appreciate the creations of nature.

Collection of Earthworms

Earthworms can be collected in plenty from garden soils particularly following rains. Do not bother to identify the species. Just distinguish that the worms may or may not have a girdle around their body near their anterior end. This girdle is called the clitellum and signifies a stage of maturity.

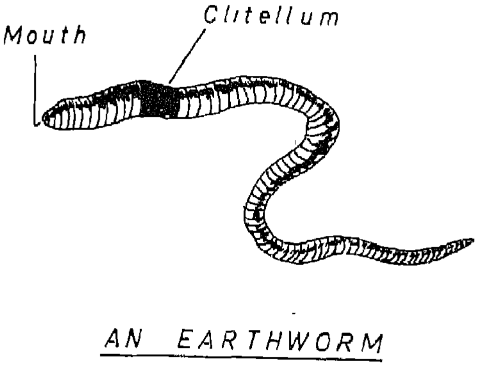

Fig. 1

Worms without a clitellum are called non-clitellates and the smaller ones (preferably less than 4 cm in length) are called the juveniles. There is no separate male earthworm or a female earthworm. Both male and female organs are present in each earthworm. Hence earthworms are hermaphrodites.

Maintenance of Earthworms

Maintenance of earthworm culture in school is a no cost experiment. Old apple cases, unused plastic buckets, flower pots or any package containers can be made use of. Fill these containers preferably with soil from where the worms were collected, mix with dry leaves and vegetable clippings from kitchen waste. These serve as ideal homes for the soil dwellers.

Remember to keep the soil moist by sprinkling water on the soil surface everyday or at least once in two days. Do not flood soil with water.

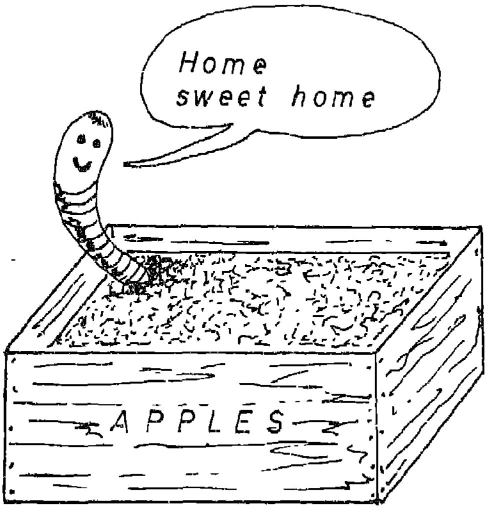

Fig. 2

Experiments to Illustrate the Characters of Living Organisms

Preparation for the Experiment: Any tray (45 cm × 30 cm) layered with moist filter paper would be ideal to demonstrate the experiment.

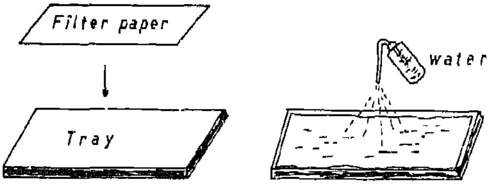

Fig. 3

i) *Living Things Move*: Place a live earthworm on moist filter paper and see how it moves. It places the anterior end forward and pulls the remaining body behind it. Each such move is called a "step". You now observe the worm "walk" forward. Touch the anterior end with a blunt glass rod or stick and watch the animal "walk" backward.

Note: Keep the earthworm moist.

(ii) *Living Things Respond to Stimuli*: In the above experiment, brush a soft camel hair brush dipped in 5 to 10% alcohol on the back of the earthworm and see how the animal "runs".

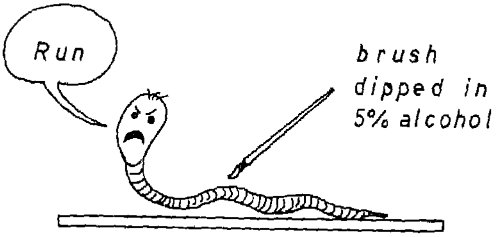

Fig. 4

Flash light (use a battery torch) on the anterior end of the worm and observe.

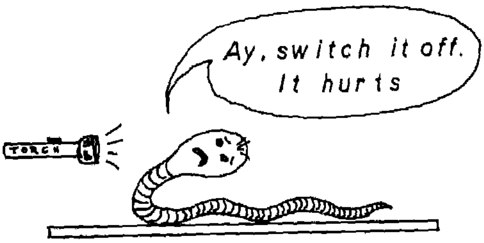
Ay, switch it off. It hurts
TORCH

Fig. 5

You would observe the worm moving away from light. Earthworm is a nocturnal animal (active only during night on surface soil) and hence moves away from light.

Now heat a glass rod and hold it close to the worm (Take care not to hurt the worm): The worm moves away from heat.

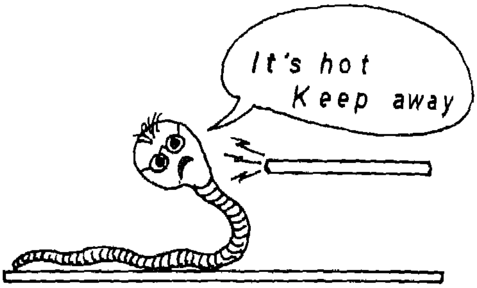

Fig. 6

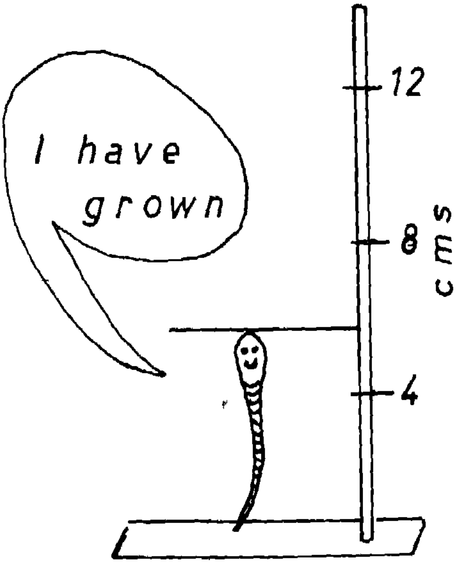

Fig. 7

(iii) *Living Things Grow*: Take juvenile earthworms and measure their length on a scale. Keep separately in petridishes containing soil and food from the culture medium. Measure after 15 days or a month and see them grow. (Remember to keep the soil moist.)

Cut the tip of the tail (2 to 3 segments) of a healthy adult earthworm with a sharp new blade. Place back in soil in petridish. Observe after a few days and explain the power of healing and regeneration of segments. (*Note*: Man also has the power of healing but cannot regenerate.)

(iv) *Living Things Respire*: Earthworms need moist surface to respire. Place an earthworm between folds of dry filter paper and absorb all the moisture from the body surface. Now place the earthworm on a dry filter paper and note how difficult it is for the worm to move. Transfer the worm to a beaker of water and watch the difference. Earthworms can live happily in water for a considerable time even without food (Remember to change water every 2 to 3 days.)

Note: The cast (faecal matter) produced by the worms usually found on the surface of the soil in the box is an excellent manure for the kitchen garden. It can be used as a biofertilizer.

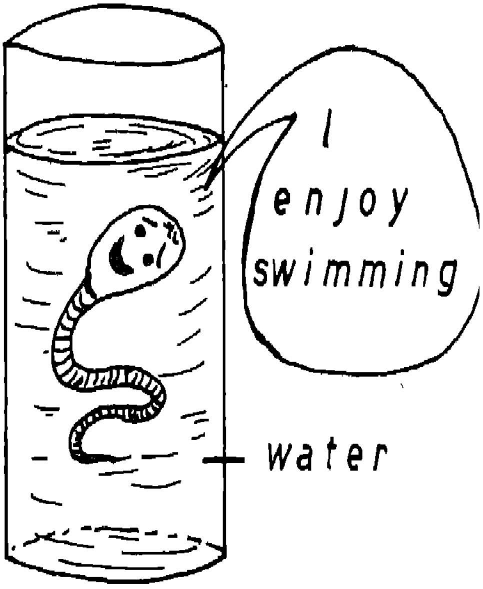

Fig. 8

Many such experiments can be designed using other harmles organisms like the cockroach or an aquarium fish. Nature has been kind enough to bestow innumerable examples. It is left to the imagination of the teacher to make use of them for providing proper knowledge and wisdom to the taught and at the same time to make his/her own teaching livelier.

World Environment Day 1991 and Green House Effect

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The present concentration of carbon dioxide in the earth's atmosphere is about 30 per cent higher than what it was in 1825. And it is quite natural Each year about 5.7 million tonnes of carbon is being added to the atmosphere and 80 per cent of it comes from fossil fuels.

As in previous years this year too, all over the world the World Environment Day (WED) was celebrated on 5th June. Every year the United Nations Environment Programme (UNEP) proposes a particular theme for the World Environment Day. This year too they did so and this year's theme was "Climate Change — Need for Global Partnership". The theme suggested by UNEP very well pointed towards an environmental issue of major concern for the present day human population. It also suggested a possible way to overcome the problem. Now, it is very well known that the climate of the planet earth is changing quite fast and it is a matter of concern as change in climate may result in large scale disturbances all over the globe. So, the theme was aimed to draw attention world wide towards this change and then it brought forward the concept of global partnership as the problem of climate change can be overcome only if actions are initiated on global level for which it is essential that people all over the globe join hands.

It was almost a century ago when the scientists expressed their concern that the temperature of the earth could increase in near future and the rise in temperature could lead to changes in climate. Recent findings have confirmed that the apprehensions of the 19th century scientists were correct. Now, it is confirmed that the average temperature of the earth has gone up by about half degree celsius as compared to the pre-industrial times. Also, it is being predicted that by the end of the next (21st) century the average temperature of earth will rise by about 3 degree celsius.

The question that automatically arises at this stage is why the temperature of the earth is rising. The scientific reason given is that "Green House Effect" is responsible for this rise in temperature So, to understand the change in temperature it is essential that we must understand the Green House Effect. This phrase has come from "Green House". Green houses are enclosures made of glass sheets or transparent plastic sheets so that sunlight can enter into them freely. These enclosures are used for growing plants in cold climates. Reason is that the temperature inside these enclosures remains higher than outside which favours growth of plants in cold climates. The scientific reason for inside temperature being higher than outside is that glass and plastic are transparent to sunlight. So, sunlight enters the green house and warms its inside. Loss of heat from inside to outside can take place through thermal rediation Glass and plastic are not transparent to thermal waves. So, this loss is reduced and as a result the heat energy is kept inside, which causes the inside temperature to rise This effect is called "Green House Effect". The same is utilised by people living in cold places when they use more glass on the sunside of their homes. This keeps their homes warmer than outside. In case of the earth, certain gases present in the atmosphere behave like glass or plastic and these gases keep the earth warm. If these gases had not been there in the atmosphere, the temperature of the earth could not have been the same as it is now. Carbon dioxide, water vapour, methane, nitrous oxide are the important gases which cause green house effect in case of the earth and keep the earth warm. Chlorofluorocarbons (CFCs) also act as greenhouse gases in the atmosphere. These gases let the sunlight reach the earth's surface to heat it, but they do not allow free passage to heat waves to move out of earth's atmosphere If the concentration of these green house gases increases in the earth's atmosphere, the greenhouse effect will increase and as a result the earth will become warmer. It has been calculated that if the concentration of CO_2 in the atmosphere doubles, the average earth temperature will rise by about 4 5 degrees celsius.

Now the question that arises is why the earth's temperature has risen in the post-industrial period and why it is expected to rise further in the future? To find answer to this question we have to look at our industrial processes. Without exception all of our industrial and developmental processes are energy based. For every industrial and developmental activity we have to spend energy and most of this energy is obtained by burning fossil fuels such as coal, oil and gas. These fossil fuels are nothing but fossilised organic matters which are rich in carbon and also they contain nitrogen, sulphur etc. When these fuels are burnt, their carbon content gets converted into carbon dioxide which enters the atmosphere. From the atmosphere the carbon dioxide is absorbed by green plants for photosynthesis and it enters the living world. Another sink for carbon dioxide is the oceans which absorb carbon dioxide. As far as the living world is concerned, the carbon dioxide will come back to atmosphere through respiration or decomposition until and unless it is converted into fossils. In nature the rate of fossilization is very slow while the rate at which we are using the fossil fuels on this earth is extremely fast. The amount of carbon which might have been fossilised in thousands of years is now being used within days or weeks. Obvious result is that there is a nett addition of carbon in the form of carbon dioxide in the earth's atmosphere. The present concentration of carbon dioxide in the earth's atmosphere is about 30 per cent higher than what it was in 1825. And it is quite natural. Each year about 5.7 million tonnes of carbon is being added to the atmosphere and 80 per cent of it comes from fossil fuels.

Methane which is another green house gas is increasing in the atmosphere at the rate of 1 to 2% per year. Its present concentration is almost double than what it was in 16th century. One of the sources of methane is the fossil fuels and another source is the livestocks. Methane is generated in their intestines. In recent times, the number of such animals has multiplied through human effort. Nitrous oxide in the atmosphere is also on increase and it is interesting to note that increase in nitrous oxide very well corresponds with the nitrogen contents of the fossil fuels being used. This again goes to prove that most of the nitrous oxide increase in the atmosphere is due to fossil fuel burning Another source is the biological denitrofication which takes place in soil and oceans. CFCs in the atmosphere are also increasing. The emission rates of CFC-11 and CFC-12 have been worked out and it has been found that these are being released at the rates of 260 and

420 million kg per year respectively. The sources for those chemicals in the atmosphere are industrial operations. CFCs are used as refrigerant gases, in aerosols and also in the manufacture of foam rubber etc. From these processes these gases escape to the atmosphere. The average annual rate of increase in the atmosphere for CFC-11 is about 65% and for CFC-12 about 110%.

Thus it can be easily concluded that most of these green house gases are being produced and added to the earth's atmosphere through the activities of human beings. And this is the reason why we find that rise in earth's temperature started when the industrial era began. After the beginning of the industrial era not only industries have multiplied at very fast rate but also human population has increased several folds. In the year 1850 the human population on this earth was about 1.0 billion and now we are about 5.4 billion. By the end of the present century the human population on this earth is expected to reach about 6.5 billion. To meet the requirements of this ever increasing population, more food has to be grown and for that we have been using more and more of fertilisers and irrigation facilities. All these directly and indirectly lead to increase in green house gases. Similarly, with the growth of transport and communication facilities required to meet the demands of growing population, we need to generate more energy and use more of various other substances. These too contribute green house gases. Result is that the discharge of green house gases to the atmosphere has been increasing since the beginning of the industrial era and if the present trend continues its discharge will increase further in coming years. Parallel to this there has been the disappearance of forests from the earth's surface. For example, during the last two decades alone, about 200 million hectares of tree cover disappeared globally. These forests could otherwise help in reducing the carbon dioxide and other green house gases. So if the earth's temperature is showing a rising trend, there is nothing unusual about it.

The next question is — why should we worry about the rising temperature? The answer is that the temperature is not an independent factor. When the temperature will change, the whole climate will be affected and once the climate is affected on this earth, every living organism and all biological and many of the physical processes will experience the impact. And when we talk of one or two degrees change in average temperature, it does not mean just one or two degrees change everywhere. In some areas the change may be only half a degree celsius while for other areas it may be as much as four or five degrees. Change of temperature to this extent may become intolerable for the biological processes. For example, it is known that natural ecosystems require about 10 years to adjust to a change of 0.1 degree celsius. This would mean that several types of ecosystems which now exist on the earth may disappear as they may not be able to withstand this change of temperature.

With warming of climate the average rainfall on the earth will increase but the distribution pattern will change. Certain areas may turn dry while other areas may receive excessive rainfall. The dry areas will have the problem of scarcity of water and desertification while the excess rain areas will have the problems of floods and soil erosion. Already we are losing some 24 billion tonnes of good soil every year globally. And if the process becomes faster due to change in rain pattern, the existence of agriculture in many parts of the world will be in danger. Similarly, desertification is already a big problem before the human race. But if it aggrevates, it may pose even greater danger. During the last two decades, the deserts on this earth expanded by about 120 million hectares and if this pace increases, we shall lose more of our agricultural lands.

Rise in earth's temperature will result in faster melting of glaciers and snow present on the mountains, poles etc. It is already known that since the beginning of last decade there has been a decrease in snow cover all around. Further increase in earth's temperature will reduce the snow cover further. And it is not the question of snow cover alone. As a consequence of the melting of snow there will be rise in sea level. The calculations indicate that already the average sea level has risen by 10–20 cm during last about one century and for future the estimations are that the rise will be of the order of 6 cm per decade. This is too big a rise. Large portions of highly productive deltaic areas all over the world will become submerged, coastal areas will be inundated, and many of the atolls will just disappear. Existence of many of the islands including the island nations will be threatened. Another consequence of sea level rise will be that ground water sources in the coastal areas will become saline resulting in shortage of fresh water.

The rise in average temperature of earth will lead to several types of health problems. Disease causing organisms will multiply faster and survive better at higher temperatures. So we may have more infections than what we have today. Diseases so far prevalent in tropical regions will appear in subtropics as with rise in global temperature areas of subtropics will become like tropics. Similarly, a large part of temperate zone will become like subtropics. But the question is "Can something be done"? The answer is yes. That is what the World Environment Day theme says in its second part. It requires actions at global level to face this problem. We have to reduce use of fossil fuels on global level. This will reduce the emissions of carbon dioxide, nitrous oxide, methane etc. We must adopt energy efficient and clean technologies. Energy efficient technologies will cut down consumption of fuels without compromising on development. For example, what we can do today with 1 litre of petrol or one kg of coal, if the same are achieved with less of these, obviously we will reduce carbon dioxide and other emissions. Next we must use clean technologies more and more which may lead to reduced emission of greenhouse gases to the atmosphere. Another step could be use of more of those energy sources which are not fossil fuel based like solar energy, wind energy, tidal energy etc. Wastes generated from one type of industry can be used as raw material for another type of industry. This will further reduce the emission of green house gases. Afforestation at large scale all over the globe can also help in tackling this problem. CFCs can be replaced by other chemicals which do not have similar properties.

All these actions have to be done by all the nations but more so by the developed nations, reason being that the contribution of developed nations in pumping greenhouse gases to the earth's atmosphere is much more than that of the poor and developing nations. The way of life is such that the requirement of energy and other resources in the developed nations is much more than in poor nations. Steps taken in poor nations can also contribute towards solution of these problems but the key lies with the rich nations.

Individual efforts are also important in this respect. For example, if we can save some electricity, some petrol, some gas through better management of energy resources and by avoiding wastage, these can be of big help. These may look small at individual level, but on global level these steps can become significant if everyone of us adopts these. Similarly, we can contribute by planting more trees and plants whenever possible. These cannot replace natural forests but these can certainly contribute in reducing carbon dioxide from the atmosphere. Organic wastes generated in our kitchen and household may easily be converted to compost. This will reduce demand and use of chemical fertilisers, leading to reduction in greenhouse effect. We very commonly use CFC filled aerosol containers. We can easily avoid them.

Thus if each nation on this earth and every individual residing on this planet decides to fight with this problem, it can be tackled It is not an impossible task.

Some Useful Formulae for the Sum of the Powers of Natural Numbers and their Application

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The natural numbers 1, 2, 3, 4, .. play an important role in our daily life and every one of us uses these in one or other form. With the development of the world, these numbers go on revealing their interesting and puzzling properties. In this article, we shall mainly deal with the sum of various powers of these numbers. The formulae regarding the sum, sum of squares and cubes of the first n natural numbers were firstly derived by Arya Bhat We proceed on to other formulae

Let the sum of rth powers i.e. $1^r + 2^r + 3^r + \ldots + n^r$ be denoted by S_r. As we know,

$$S_1 = n(n+1)/2,$$

$$S_2 = n(n+1)(2n+1)/6.$$

If $S_1 = x$ and $S_2 = y$, then the following formulae hold good·

(i) $S_3 = x^2$

(ii) $S_4 = y(6x - 1)/5$

(iii) $S_5 = x^2(4x - 1)/3$

(iv) $S_6 = y(12x^2 - 6x + 1)/7$

(v) $S_7 = x^2(6x^2 - 4x + 1)/3$

(vi) $S_8 = y(40x^3 - 40x^2 + 18x - 3)/15$

(vii) $S_9 = x^2(16x^3 - 20x^2 + 12x - 3)/5$

(viii) $S_{10} = y(48x^4 - 80x^3 + 68x^2 - 30x + 5)/11$

(ix) $S_{11} = x^2(16x^4 - 32x^3 + 34x^2 - 20x + 5)/3$

Proof

(i) Consider,

$$(1+2)^2 = (1^2 + 2^2) + 2\cdot 1\ 2$$

$$(1+2+3)^2 = (1+2)^2 + 3^2 + 2\cdot(1+2)\ 3$$

$$= (1^2 + 2^2 + 3^2) + 2\ 1\ 2 + 2\ (1+2)\ 3$$

In general,

$$S_1^2 = S_2 + 2[1\cdot 2 + (1+2)\ 3 + \ldots + (1 + 2 + \ldots + \overline{n-1})\ n]$$

or

$$x^2 = y + 2\sum_{k=1}^{n} (1 + 2 + \ldots + \overline{k-1})\cdot k$$

$$= y + 2\sum_{1}^{n} K\,K\,(K-1)/\ 2$$

(Using formula for the sum of first $K - 1$ natural numbers)

$$= y + \sum_{1}^{n} (K^3 - K^2)$$

$$= y + \sum_{1}^{n} K^3 - \sum_{1}^{n} K^2$$

$$= y + S_3 - S_2$$

which gives

$$\boxed{S_3 = X^2}$$

(using $S_2 = y$)

(ii) Consider,

$$(1^2+2^2)(1+2) = (1^3+2^3) + 1^2\cdot 2 + 1\cdot 2^2$$

$$(1^2+2^2+3^2)(1+2+3) = (1^2+2^2)(1+2) + 3^3 + (1^2+2^2)\cdot 3 + (1+2)\cdot 3^2$$

$$= (1^3+2^3+3^3) + 1^2\cdot 2 + (1^2+2^2)\cdot 3 + 1\cdot 2^2 + (1+2)\cdot 3^2$$

In general,

$$S_2S_1 = S_3 + [1^2\cdot 2 + (1^2+2^2)\cdot 3 + \ldots + (1^2+2^2+\ldots+\overline{n-1}^2)n] + [1\ 2^2 + (1+2)\cdot 3^2 + \ldots + (1+2+\ldots+\overline{n-1})n^2]$$

or

$$xy = x^2 + \sum_{k=1}^{n} (1^2+2^2+\ldots+\overline{K-1}^2)\cdot K + \sum_{K=1}^{n}(1+2+\ldots+\overline{K-1})\cdot K^2$$

$$= x^2 + \sum_{K=1}^{n} [K(K-1)(2K-1)\cdot K/6 + K(K-1)K^2/2]$$

(Using formulae for the sum of first and 2nd powers of first $K-1$ natural numbers)

or

$$6xy = 6x^2 + \sum_{K=1}^{n} K^2(K-1)(5K-1)$$

$$= 6x^2 + \sum_{1}^{n} (5K^4 - 6K^3 + K^2)$$

$$= 6x^2 + 5\sum_{1}^{n} K^4 - 6\sum_{1}^{n} K^3 + \sum_{1}^{n} K^2$$

$$= 6x^2 + 5S_4 - 6S_3 + S_2$$

$$= 5S_4 + y, \quad (\text{Using } S_3 = x^2)$$

which gives

$$\boxed{S_4 = y(6x-1)/5}$$

$$= n((n+1)(2n+1)(3n^2+3n-1)/30$$

(iii) Consider,

$$(1+2)^3 = (1^3+2^3) + 3\cdot 1\cdot 2\cdot(1+2)$$

$$(1+2+3)^3 = (1+2)^3 + 3^3 + 3\cdot(1+2)\ 3\ (1+2+3)$$

$$= (1^3+2^3+3^3) + 3\cdot 1\cdot 2\cdot(1+2) + 3\cdot(1+2)\cdot 3\cdot(1+2+3)$$

In general,

$$S_1^3 = S_3 + 3[1\cdot 2\cdot(1+2) + (1+2)\cdot 3\cdot(1+2+3) + \ldots + (1+2+\ldots+\overline{n-1})\cdot n\cdot (1+2+3+\ldots+n)]$$

or

$$x^3 = x^2 + 3\sum_{K=1}^{n} (1+2+\ldots+\overline{K-1})\cdot K\cdot(1+2+3+\ldots+K)$$

$$= x^2 + 3\sum_{K=1}^{n} K(K-1)/2\cdot K\cdot K(K+1)/2$$

or

$$4x^3 = 4x^2 + 3\sum_{K=1}^{n} (K^5 - K^3)$$

$$= 4x^2 + 3\sum_{1}^{n} K^5 - 3\sum_{1}^{n} K^3$$

$$= 4x^2 + 3S_5 - 3S_3$$

$$= x^2 + 3S_5 \quad (\text{Using } S_3 = x^2)$$

which gives

$$\boxed{S_5 = x^2(4x-1)/3}$$

$$= n^2(n+1)^2(2n^2+2n-1)/12$$

Similarly, by considering the expansions of $(1^2+2^2)(1^3+2^3)$, $(1+2)^4$, $(1^5+2^5)(1^2+2^2)$, $(1+2)^5$, $(1^7+2^7)(1^2+2^2)$, $(1^5+2^5)^2$, we get the formulae for S_6, S_7, S_8, S_9, S_{10} and S_{11} respectively.

Relation between the Formulae

Let $'$ denote differentiation with reference to x. Then it is easily seen that $S'_3 / S_2 = 2x / y$, $S'_5 / S_4 = 10x / 3y$, $S'_7 / S_6 = 14x / 3y$, $S'_9 / S_8 = 6x / y$, $S'_{11} / S_{10} = 22x / 3y$. Thus these are the terms of an arithmetic sequence with first term $2x / y$ and common difference $4x / 3y$. The general term being given by

$$S'_{2K+1} / S_{2K} = 2(2K + 1)x / 3y$$

Will the relation hold for all values of K remains unsolved.

With the help of this relation, it is easy to get $S_3, S_5, S_7, \ldots$ whenever $S_2, S_4, S_6, \ldots$ are given respectively and vice versa. As an example, we find S_7 using S_6.

We have

$$S'_7 / S_6 = 14x / 3y$$

or

$$S'_7 = 14x / 3y \times y(12x^2 - 6x + 1) / 7$$

$$= 2x(12x^2 - 6x + 1) / 3$$

Integrating w.r.t. x, we get

$$S_7 = 2(3x^4 - 2x^3 + x^2 / 2) / 3 + C,$$

(being constant of integration)

$$= x^2(6x^2 - 4x + 1) / 3 + C$$

But when $x = 1$, $S_7 = 1^7 = 1$, with these values, $C = 0$ and

$$S_7 = x^2(6x^2 - 4x + 1) / 3$$

Application to Definite Integrals

We know that

$$\int_a^b f(z)dz = \text{Lt}\, h[f(a + h) + f(a + 2h)$$

$$+ \ldots + f(a + nh)]$$

where $h \to 0$, $n \to \infty$ and $b - a = nh$.

Now

$$\text{Lt}h^2x = \text{Lt}h^2n(n + 1) / 2 = \text{Lt}nh(nh + h) / 2$$

$$= (b - a)^2 / 2$$

$$\text{Lt}h^3y = \text{Lt}h^3n(n + 1)(2n + 1) / 6$$

$$= \text{Lt}nh(nh + h)(2nh + h) / 6$$

$$= (b - a)^3 / 3$$

with these results, we evaluate the integral when $f(z) = Z^4$.

We have

$$\int_a^b Z^4 = \text{Lt}h[(a + h)^4 + (a + 2h)^4$$

$$+ \ldots + (a + nh)^4]$$

$$= \text{Lt}h[na^4 + 4a^3hS_1 + 6a^2h^2S_2$$

$$+ 4ah^3S_3 + h^4S_4]$$

$$= \text{Lt}[nha^4 + 4a^3h^2x + 6a^2h^3y + 4a(h^2x)^2$$

$$+ h^3y(6h^2x - h^2) / 5]$$

$$= (b - a)a^4 + 2a^3(b - a)^2 + 2a^2(b - a)^3$$

$$+ a(b - a)^4 + (b - a)^3 / 3[3(b - a)^2 / 5]$$

$$= [5(b - a)a^4 + 10(b - a)^2a^3 + 10(b - a)^3a^2$$

$$+ 5(b - a)^4a + (b - a)^5] / 5$$

$$= [(b - a + a)^5 - a^5] / 5$$

$$= (b^5 - a^5) / 5$$

Innovative Methods of Teaching Science

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If we probe into the nature of scientific investigation carried out by scientists, it becomes evident that science is essentially empirical. No idea in science survives because it is pleasing or elegant but because it weathers the test of not only one experiment but several experiments. Experimentation, thus, provides objectivity to science.

The title of the topic consists of three important terms: Innovative, Teaching and Science. Let us consider what each of them individually conveys so that we may be able to have a close look at the conceptual matrix of the title of our discussion. The word 'teaching' is the central word, not merely in a physical sense but more so in conceptual sense. Let us, therefore, probe it first.

What is Teaching?

Teaching is normally visualized as a process of imparting knowledge having teacher at the transmitting end and a group of pupils at the receiving end. If so, is the teacher expected to play the role of an undisputed source of knowledge, above all suspicion about his authority and the pupil as an 'alumnus', he who is to be fed with information. But then, what about the saying: he who teaches least is the best teacher? It raises a very important issue of learning by pupils. Is then teaching effectiveness to be assessed in the context of the extent to which the pupil's learning has occurred? How teaching is to be defined then? Is it simply telling or explaining or is it guiding, motivating or stimulating. Is it something of all these or more? We know from Piagèt that learning occurs only as a result of an active efort on the part of the pupil himself. Research has further indicated that understanding is facilitated by means of fixed assimilation patterns peculiar to each individual. As such, oral teaching stands challenged.

Teaching as a process seems to consist of different stages. The first stage concerns with the prerequisites, conditions necessary for teaching. It includes activities designed to promote communication, motivation, attitudes favourable to learning, good interpersonal relationship between teacher and students and a group-climate conducive to learning. The second stage concerns with the selection and presentation of activities designed to promote the aims of education bearing in mind the characteristics of the learner and how the students learn. The research has established that there is a sequence in the development of mental structures. Thus, the teacher should make concerted efforts to assess the level of development of children and analyse the epistemology of the 'Knowledge' to be imparted. This will help to match the task being set and the child's operative ability. The third stage relates to appraisal, evaluation and feedback. The feedback can be to the aims (whether possible or impossible to achieve), to the student's characteristics (whether they require more/less challanging materials), to the curriculum (whether the instructional materials are dull or interesting), to the teaching itself (whether there is a need for more emphasis as problem solving) or to any other part or aspects of the teaching process.

The self-corrective mechanisms of feedback ensure the continued growth and validity of teaching as contrasted with the rigour mortis of routinization. Does it emerge from the above considerations that 'teaching' is a package of activities designed and performed to produce desired changes in student behaviour?

What is Science?

Is it the accumulated knowledge acquired through the mastery of scientific concepts and theories? Is science composed of inventions and development of machines and gadgets or highly developed technology of the modern world? If we probe into the nature of scientific investigation carried out by scientists, it becomes evident that science is essentially empirical. No idea in science survives because it is pleasing or elegant but because it weathers the test of not only one experiment but several experiments. Experimentation, thus, provides objectivity to science.

The informational facts gathered by observations and experiments are the structural elements of science. The form of science is established by the organisation of these facts into systems, generalization and theories. Probably, the first step in the organization of knowledge beyond simple observation is the process of classification. It is also known as analysing. In the subsequent stages of the growth of science that make it powerful, dynamic social force, the next step in system formation is a search for explanation. Here, we advance a postulate. It is termed as hypothesizing. It is also known as synthesizing or generalizing.

Therefore, science with experiement only would be a dull thing. It is the theories tying facts together that provide the challange and the reward of science. The new way of looking at nature, the unexpected relations between different facts, the single equations governing a vast range of phenomena — these are the things that give to science its stature and elegance.

Although the hard evidence of experiment can destroy theory, no amount of experimental verification can immortalise a theory. Also, a theory has to remain tentative for two reasons. First, the theory is likely to be capable of making infinite number of different predictions but man's finite capabilities limit his ability to test all predictions. He tests only what he deems most important and therefore a subtle hidden flaw may go undetected. Newton's theory of mechanics survived two centuries of exhaustive tests, but finally the flaw appeared. Second, n^0 theory is unique. The possibility must always remain open that a theory is supported not because experimental evidence forces its rejection, but just because an alternate theory, although neither better nor worse experimentally, is found more satisfying from other considerations. It may be conceptually or mathematically simpler or appear in some way to be more deeper, more profound and therefore more pleasing aesthetically. This human judgment of theory is as important as experiment itself in shaping the structure and the progress of science.

The important point as explained above is that all postulates of science are constantly evolving, suffering modifications, additions, deletions and sometimes total destructions. Thus another important aspect of science is hypothesizing, having openness and tentativeness as the special characteristics of the hypothesis. Does it follow from the above deliberations that scientific investigation is the systematically organized intellectual activity directed towards better understanding and control over the nature?

What is Innovation?

Does innovation simply mean introducing a definite change in a given situation? Is such change intended to achieve something? If so, what? Probably an effort to probe the above questions further will help us to appreciate what is really implied by the word 'innovation'.

Having deliberated the various aspects of *teaching*, *science* and *innovation*, we may now be in a position to develop a matrix of the innovative methods of teaching science. In this context, the controversy about emphasis upon content versus process in science teaching is required to be resolved. Also, the common belief of essentiality of sophisticated equipment and facilities of good laboratories for effective science teaching need to be critically examined.

In view of the above, the following appear to be the ingredients of the innovative methods of teaching science:

(i) Creation of the conditions for exploitation of unlimited potential of the human brain,

(ii) Encouragement of the universal use of scientific process, and

(iii) Subordination of all learning activities to the developmental sequence of motor, verbal and mental behaviour of a child.

Implications of Brain Research for Mathematics Educators

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> *Children can know without being able to state their thoughts in words. So language should not be considered as the only vehicle for thought when visualization is more appropriate.*

Recent developments in neurophysiology have enormously advanced our knowledge about the functioning of brain in human body. The human brain is composed of two mirror-image hemispheres and several commissures, e.g., bands of nerve fibres which connect the hemispheres. The largest of these commissures is the Corpus Callosum which provides powerful communication between the two hemispheres (Fig. 1).

It communicates the information so rapidly that everything happening in one hemisphere is immediately processed in the other. Moreover, it appears that the two hemispheres respond differentially to different kinds of stimuli and that the modes of processing information may differ between the two hemispheres. The right hemisphere primarily controls the left side of the body and the left hemisphere controls the right side of the body. When a person sustains an head injury on the left side he/she loses speech capacity or when the injury is on the right, speech is not affected. Difference in the functioning of the two hemispheres is therefore a well-established fact.

The split-brain research has further led to the strong medical/scientific support of the fact that left hemisphere deals with analytic, numeric and verbal aspects and the right hemisphere (brain) is sensitive to visual and creative aspects. Johnson presents a typical listing as she differentiates the way the two hemispheres perceive information and the ways they process that information.

Information Perception

Left Hemisphere	*Right Hemisphere*
abstract symbols	visual images
language	language
reading	expression, tone
speaking	body language, gestures
writing	facial expressions
mathematics	mathematics
numeral	shapes
basic facts	patterns
computation	relationships
logic	time-linear creativity
time-linear	time-cyclical
music-rhythm	music-melody
	functions

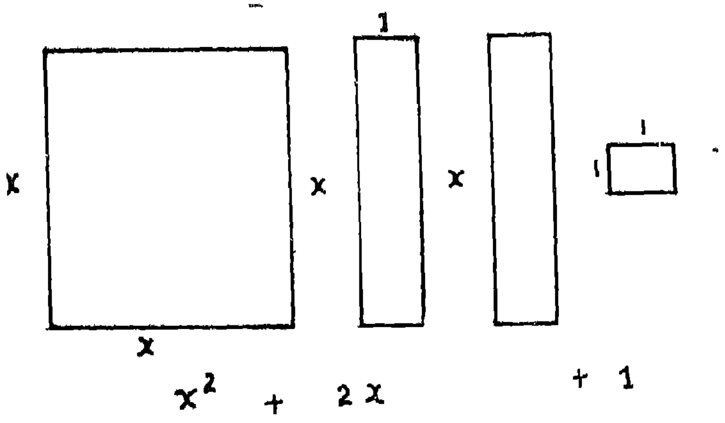

Fig. 2

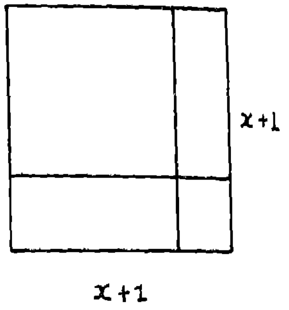

Fig. 3

Concept of probability introduced in the school syllabus can be explained by creating experiments which require students to make predictions. For example a coin is tossed five times and students may be asked to note the probability of finding heads or tails. Or, take a container and have students put 5 red, 5 white marbles in it. The marbles are withdrawn one at a time and then replaced in the container. The students are asked to compute the theoretical probability of withdrawing one white marble out of three or five marbles out of ten attempts. Then the students can be asked to withdraw marbles from the container, record the colour of this marble and put it back into the container. They can repeat this 20 times and compare their results with theoretical probability. Activities such as these enable students to visualize abstract situations concretely. Moreover, a key to success in effectively teaching mathematics is the manipulation of concrete objects.

Lastly, we assert that since brain is the central organ for learning, the knowledge about its functioning must find an enduring place in the attention of mathematics educators so that educational practices are based on such empirical lines.

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SCIENCE NEWS

Antarctica Conservation Strategy

A meeting was held in Madrid to discuss a new strategy to preserve Antarctica as a unique wilderness and a global scientific research location. The key question before this special consultative meeting of Antarctic treaty nations was where protection of the environment ranked in the hierarchy of Antarctic concerns, says Dr. Martin Holdgate, Director-General of IUCN, the World Conservation Union which had prepared a strategy for Antarctica conservation. "The overwhelming majority of members — 53 Governments, 93 Ministries and State agencies and 450 of the world's leading non-Governmental organizations — believe strongly that the touchstone of acceptability of any activity in Antarctica should be its compatibility with environmental conservation", he says. Around 300 delegates from more than 30 countries attended the meeting

The union's policy paper covers the whole range of activities in Antarctica. It calls for a strategic plan for science so that research stations will be spaced and located where the best work can be done.

It urges a new approach to the protection of sites and species within Antarctica and it highlights the use of marine resources of the Antarctica seas and exploration and mining of metals and petroleum.

The possibility of mineral exploration and exploitation in Antarctica has recently attracted attention and caused concern throughout the world.

The resolution adopted by the Perth general assembly of IUCN in December 1990 makes it very clear that mineral activities are incompatible with conservation in Antarctica. For this reason it has been proposed that these activities be excluded permanently by a binding, international, legal commitment.

The human community does not need Antarctic Resources. The world is awash with fossil fuels. There are good prospects for great economies in use of fossil fuel energy. We have to cut down on this use if we are to avoid the risks of atmospheric and climatic perturbation. The costs of any mineral extraction from Antarctica are immense and the benefits dubious.

Dr. Holdgate, a biologist who has spent a considerable part of his scientific career in Antarctica and writing about it, says that many scientific activities in the Antarctic today are fully compatible with environmental conservation. "But a number of them have been located in areas that are not ideal from a scientific standpoint", he says.

The policy paper urges that the treaty powers, in cooperation with the Scientific Committee on Antarctic Research (SCAR), prepare a strategic plan for Antarctic science over the next 30 years. The plan would cover the location of bases, international cooperation for their use, the exchange of personnel and cooperation in scientific work so that the very best results for all humanity come from the massive investment required to maintain any kind of presence in the far south.

Expressing concern about the way in which damage has been caused by past practices of waste disposal and contamination the strategy calls for additional restrictions on the dumping of wastes at sea, particularly chemicals, agreed standards for shipboard equipment to manage ship- generated garbage and weighing the advantages and disadvantages of incineration.

A major aspect of the union's strategy for Antarctic conservation concerns protected areas. While there were 19 specially protected areas (SPAS) and 31 sites of special scientific interest (SSSIS) in 1989, the IUCN feels these sites are too few in number and not truly representative of all Antarctic ecosystems.

Another important section of the document deals with tourism. Tourism in Antarctica? That may come as a surprise to many. But up to 5,000 tourists have visited Antarctica in a year and their numbers are growing.

A proposal to construct a major new base on the continent in the vestfold hills in the Australian sector complete with a permanent runway and hotel accommodation, was under consideration, although it has now been rejected.

The strategy says. "The conservation of Antarctica also needs to be seen in a wider context — the world needs to conserve energy and to minimize discharge of greenhouse gases."

Climate change threatens to undermine worldwide efforts for conservation and to erode the sustainability of essential development. Antarctica has a central and major influence on world climate and its conservation is all the more important for this reason.

In this sense, Antarctica is a symbol and perhaps a watershed. Its conservation, free from mineral resource extractive activity would be a demonstration that the world community is committed to the path of sustainability and to a future of harmony for humanity within nature. The goals of conservation in Antarctica are most likely to be attained if human impacts are minimized.

Refrigerators Major Threat to Ozone Layer

It may not apparently seem so, but the world's one billion household refrigerators are ticking time bombs, says Ms. Cynthia Dollock Shea, a writer in *World Watch* magazine.

Locked within their cooling systems and insulating panels, she notes, are millions of modules of chlorofluorocarbons, powerful agents of environmental destructions awaiting release.

Inert gases at ground level CFCs, turn into deadly ozone hunters when they drift into the stratosphere, where they can survive for up to a century. One CFC molecule can destroy 200,000 ozone molecules once it is released.

By depleting ozone, which shields the earth from harmful ultraviolet radiation, CFCs ultimately contribute to reduce crop and fishery yields and increased rates of skin cancer and cataracts.

They are also potent greenhouse gases that, molecule for molecule, absorb 10,000 times as much infrared radiation as carbon dioxide, thus contributing to about one fifth of the global warming.

With up to 2.5 pounds of CFCs each, she says, the 50 million refrigerators discarded worldwide every year are a major threat to the atmosphere. In addition, being large and bulky, they take up precious landfill space.

Germany has the most sophisticated system to dispose of the abandoned appliances. A recently developed German technology multiplies the environmental benefits of the programme by capturing and reusing the CFCs found in insulating foam. Sweden, Switzerland and the Netherlands are now developing their own recycling programmes. In the USA by contrast, says the writer, the amount of CFCs used in each unit is still on the rise.

Gene that Controls Sex

An experiment on a mouse proves that one gene controls sex, according to British researchers quoted in an issue of the scientific journal, *Nature*.

Two researchers from the Medical Research Council and the Imperial Cancer Research Fund injected the gene called 'sry' and discovered last July, into the embryo of a female mouse. Since the mouse was born six weeks ago, as a male, it has acted entirely as a normal male — except that it is sterile.

There are no detailed observations, but copulation behaviour of the mouse was normal, mating four times in six days, said the researchers

The experiment demonstrated three points, Dr. Robin Lovell Badge of the MRC said. "First, all the genetic information needed to send the embryo on the pathway of male development is contained in just one gene. Second, there can be no doubt that it is a gene called 'sry'. Finally, female embryos have all the other genes required for making a male — all it takes is 'sry' to activate them. Dr. Peter Goodfellow of the ICRF added, "it opens the way to understanding the complex series of genetic events which control development and may also shed light on complicated developmental diseases such as cancer."

Instant Blood Value Indicator

Blood circulation deficit (BCD) value indicator is a unique diagnostic instrument developed by a Soviet doctor. The compact, computerized digital BCD value indicator has been demonstrated at the Sancheti Institute for Orthopaedics and Rehabilitation by Dr. A.M. Bardorin, the laser surgeon who has developed the unit.

The small 3.5 kg unit can give the BCD and hematocrite values from 0.99% within two minutes, based on the various parameters fed into the computer as against the American method of radioisotopes, which takes two to three hours. Dr. Bardorin said, repetition in the U.S. method is not possible before eight hours, while the BCD indicator could be noted continuously for 12 hours, he added.

The high-precision and rapid measurement equipment works on a conductometeric technique and the quantity of blood required for diagnosis is just one to 1.5 ml.

Asked how long he has been using the equipment, Dr. Bardorin said, a large number of clinics in the Soviet Union have been using the BCD and that it has received a certificate of approval in Bulgaria while queries have also been received from the Gulf.

Parts of Earth Have 'Natural Thermostat'

Some parts of the earth have a "natural thermostat" that automatically cools the planet's surface when it gets too hot, according to Mr. Veerbhadran Ramanathan and his colleagues at the Scripps Institution of Oceanography and the University of California.

A paper on their findings in *Nature* says, when sea surface temperatures in the tropical pacific rise above 27 degrees celsius, the amount of water vapour in the air increases dramatically. That aggravates the heat trapping "Greenhouse" effect.

But it also triggers a second, even more powerful phenomenon; the hot, moist air gains so much energy that it forms intense convection currents and punches up into the highest reaches of the troposhpere, where it spreads out into a broad thin cloud canopy.

At attitudes of 19 or 20 km, the water vapour forms ice crystals that are so shiny that they reflect back much of incoming sunlight, shading the area beneath them and in turn cooling the sea surface.

This feedback mechanism, Mr. Ramanathan and his colleagues say, apparently limits ocean surface temperatures in the warmest regions of the earth to less than 39 degrees. Understanding and modelling that process may also help scientists anticipate some effects of global warming.

Mr. Stephen Schneider, a climatologist at the National Centre for Atmospheric Research in Boulder, Colorado cautioned that the "thermostat" effect should not be viewed as reducing the potential severity of global warming, partly because only 15 to 20% of the earth's surface is covered by tropical oceans.

Newly Found Black Hole

A team of U.S. astronomers recently discovered a mysterious dark object in space that is 100 billion times more massive than the sun and may be a black hole, according to a study.

Astronomers, Mr. Joss Bland Hawthorn of Rice University of Maryland and Mr. R. Brent Tully of the University of Hawaii, said in a statement that if the object is a black hole, it would be 10 to 100 times larger than any previously discovered black holes.

"This huge mass and its great concentration and darkness are puzzling and unlike any found previously," said Mr Bland Hawthorn. "It may provide further evidence of the existence for dark matter in space — matter that radiates little or no light."

Gene Therapy Shows Result

A four-year-old girl who is the world's first recipient of gene therapy to correct an inherited disease has improved enough to ice skate, take dancing lessons and begin a normal life, according to her doctor.

"We know we're doing something positive", Dr. Kenneth Culver a pediatrician at the National Institute of Health in Bethesda, Maryland, said. His update on the child's condition is the most optimistic assessment her doctors have yet provided.

Before the historic therapy, the child was so susceptible to infections that she was confined to her home. Her siblings and her mother also stayed inside house fearing they would bring infection. A common cold could have been fatal. The child, whose identity has not been disclosed, was born with a defect in a single gene that left her without an immune system to protect against disease.

In an experiment that began on September 14, 1990 some of the child's blood cells were removed, injected with normal copies of the damaged gene, and returned to her blood stream.

The normal genes began to trigger production of missing enzyme that is critical to the function of the immune system. The levels of the enzyme in her blood are now up to 25% of the normal.

Alcohol's Effect on Foetus

Expectant mothers who take alcohol either occasionally or regularly face the danger of giving birth to offsprings with permanent mental disabilities and behavioural problems. The first systematic study on long-term consequences of Foetal Alcohol Syndrome, conducted recently by Dr. Ann P. Streissguth, psychologist of the

University of Washington in Seattle, and her colleagues, revealed this fact.

FAS victims, both adolescents and adults, often appear alert and do not show verbal disabilities during childhood. The study, however, found that they could not live independently, hold jobs or succeed in academics due to poor concentration, social withdrawal, impulsiveness, inability to consider the consequences of their actions and had related problems.

Dr. Streissguth said mental retardation also occurs in a majority of FAS cases. Moreover, debilitating behavioural problems plague those with normal and low IQs.

"FAS is not just a childhood disorder", Dr. Streissguth's team pointed out in a recent issue of the journal of American Medical Association. There is a predictable long-term progression of the disorder into adulthood.

The researchers studied 38 men and 23 women ranging between 12 and 40 years. In 43 test cases, FAS was diagnosed before 12 years and the other 18 had prior diagnosis of "possible foetal alcohol effects". Many were short-statured for their age with unusually small heads, the study said.

Test-Tube Baby Born in 'Natural Cycle'

A test-tube baby in the "natural cycle" without usage of drugs, was born at *invitro* fertilization test-tube baby centre in Madras private hospital on March 20.

Dr. (Mrs) Zubaida Begum, chief of the centre, said that the "natural cycle" was a procedure in which drugs in the form of tablets or injection were not administered to the patients.

Two more cases of test-tube babies in "natural cycle" had completed four months of pregnancy successfully, Dr. Begum added.

Dr. Begum said that experiments were going on at the centre, "Shifa Hospital and Research Centre", to preserve embryos by freezing them for a period of time. Usage of drugs induced the production of more number of eggs compared to the natural cycle, wherein only one egg might be located, she said.

The natural cycle method costs about 50–60% less than that using drugs before conception of the child, she said. This was possible as usage of drugs and laboratory tests were avoided.

Remedial Science Students' Understanding of Selected Chemistry Concepts During Their Post-Primary School Science Programme

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The present study was undertaken with a view to evaluate the understanding of the basic concepts in chemistry needed by remedial entrants for pure and applied science-based degree courses.

Introduction

The notion that tertiary institutions bear some responsibility for helping students overcome weaknesses in academic backgrounds and skills has been expressed in literature Morse and Clapp (1980) in their concern for the student who comes to the college chemistry ill-prepared had proposed various solutions to students' weaknesses in the introductory chemistry courses. Their alternatives approach to teaching freshman chemistry through problem-solving led to improved performance by students. Niedzielski and Walmsley (1982) had recognized the general deficiency in students' chemistry background as they opt for remedial freshman chemistry courses for the various science based programmes in tertiary institutions. Their research provided an insight into the specific chemistry concepts that should be mastered by a freshman after completing the freshman chemistry programme Rouse (1981) had observed that most students backgrounds in remedial freshman chemistry classes range from no previous chemistry to two years of high school chemistry. Remediation, therefore, would imply helping a student overcome academic deficiencies in order that the student may enter a university remedial science programme for degree courses in the natural and applied sciences. Such work mainly consists of non-credit courses in biology, chemistry, English, mathematics, and physics taken as prerequisites to degree courses.

Most universities in Nigeria require credit at General Certificate of Education Ordinary Level (GCE O/L) in some of the natural sciences for degree courses in the faculties of agriculture, engineering, medicine, and the sciences (JAMB Brochure, 1988/89 session). Academic performance clearly becomes the *sine qua non* for the validation of most universities remedial courses. The validating criteria consist of grades and test scores. But recent statistics in sessional results in chemistry for remedial entrants in the University of Cross River State (UNICROSS) indicate a poor trend of performance. The trend is illustrated in Table I.

TABLE I

1984-88 Remedial Chemistry Results

Year	Number of Students	Percentage Scoring Grade C and Below*
1984/85	139	96%
1985/86	125	74%
1986/87	125	93%
1987/88	150	69%

*UNICROSS assigns a letter grade of C to scores of 50%–59%

In an attempt to get to the solution to the problem of what to do for the student who comes to remedial chemistry ill-prepared, it was thought of interest to undertake this study with a view to:

1. Evaluating the understanding of the basic concepts in chemistry needed by the UNICROSS remedial entrants for degree courses in the Faculty of Pure and Applied Sciences
2. Identifying the concepts which are not very well understood by students.
3. Teaching the identified concepts with appropriate treatment and emphasis; and
4. Comparing the entry performance of students with their terminal course examination in chemistry.

Methodology

Sample: The sample for the present study comprised of two sets of randomly selected UNICROSS remedial science students; viz, 100 remedial science students for the 1986/87 school year, and 150 remedial science students for the 1987/88 school year. Table II presents the demographic information of the sample.

A break down by sex indicated that for the 1986/87 school year 60 males and 40 females took part in the study, while the sample consisted of 81 males and 69 females in the 1987/88 school year. Most of the remedial entrants had attended urban secondary schools. Only 70 of the 150 entrants in the 1987/88 school year had the pre-entry academic qualification of the General Certificate of Education Ordinary Level (GCE O/L) in chemistry. Similar qualification had been indicated by 55 out of 100 respondents during the 1986/87 school year. Other relevant academic experiences of the respondents were as spelled out in Table II.

Instrument: A 40-item multiple choice pre-test of internal consistency 0.58 was developed by the researchers and administered to similar subjects prior to the experiment. The pre-test concepts were derived from the work of Zimelis (1981); and the recent syllabus contents of the Comparative Education and Adaptation Centre (CESAC 1985) Chemistry Curriculum. About twenty school certificate level concepts based on the syllabi were selected. Two multiple choice questions, each having five options, were asked of each concept.

Four experienced chemistry lecturers were asked to validate the instrument. Their comments and suggestions were incorporated in the final draft of the instrument which tested the concepts listed in Table III.

Administration: The final draft of the instrument was administered to randomly selected remedial science students during the 1986/87 and 1987/88 academic sessions respectively. By each session, the test was promptly administered during the first week of reopening. This was to ensure that the subjects' responses were not affected by University instruction. The results of the pre-test and post-test for the 1986/87 remedial

TABLE II

Respondents' Demographic Information

	Variable	Distribution	Number			
1.	Sex	Male	81		60*	
		Female	69		40*	
2	School Location	Urban	80		55*	
		Rural	70		45	
			O/Level GCE	Form 5	Form 4	Form 3
3	Respondents' Pre-Entry	Biology	84	106	108	111
	Academic Experience with		71*	90	100*	100*
	Science (GCE/	Chemistry	70	100	101	104
	O Level score		55*	80*	95*	98*
	at Credit Level)	Physics	30	71	76	80
			20*	31*	40*	60*
		Mathematics	50	116	119	150
			21*	95*	98*	100*

*Asterisked numbers denote 1986/87 demographic information of 100 respondents; non-asterisked numbers denote 1987/88 information of 150 respondents.

entrants provided the basis for identifying and reteaching the concepts which seemed difficult to the 1987/88 students. The identified difficult concepts were given appropriate treatment and emphasis during the 1987/88 school year. By the end of the 1987/88 session, therefore, students had a post-test of the designed instrument and their regular end of course examination in chemistry.

Data Analysis

The data was analysed by grading the answer sheets of the respondents. The index of difficulty for each item of the test was computed as specified by Lindeman and Merenda (1979) by "dividing the number of pupils passing the item by the total number of pupils in the combined high and low groups" The average difficulty index for every two multiple choice questions asked of each concept was calculated The cut-off values for high, middle, and low range of difficulty was empirically determined as 0.66 to 0.99; 0.46 to 0.65, and 0.10 to 0.45 respectively. The results are presented in Table III.

The mean score and standard deviation were calculated for the two sessions' test scores. The levels of performance between the pre-test and the post- test of each session were then compared and their significance levels estimated by

TABLE III

Test Concepts and Response Patterns Among Students

Test Concepts		1986/87* Test Scores				1987/88** Test Scores			
		No Right		Difficulty Index		No Right		Difficulty Index	
		Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
1.	Separation and Purification of Substances	85	92	0.80	0.95	116	140	0.77	0.93
2.	Chemical Combinations	54	60	0.52	0.63	60	79	0.40	0.53
3.	Kinetic Theory of Matter	36	39	0.25	0.35	35	28	0.23	0.19
4.	Gas Laws	64	60	0.63	0.61	58	63	0.39	0.42
5.	Periodic Table and Bonding	75	92	0.72	0.90	89	97	0.59	0.65
6.	Chemical Measurements	50	57	0.48	0.52	58	54	0.39	0.36
7.	Water	37	45	0.35	0.41	38	43	0.25	0.29
8.	Solubility	44	47	0.43	0.44	43	54	0.29	0.36
9.	Acids,Bases and Salts	60	65	0.62	0.68	72	43	0.48	0.29
10.	Oxidation and Reduction	49	54	0.46	0.52	58	55	0.39	0.37
11.	Electrolysis	34	31	0.30	0.28	24	41	0.16	0.27
12.	Energy Changes	75	80	0.72	0.76	84	80	0.56	0.53
13.	Rates of Reactions	35	32	0.32	0.29	31	29	0.21	0.19
14.	Chemical Equilibrium	46	49	0.42	0.46	48	59	0.32	0.39
15.	Metals and their Compounds	78	76	0.77	0.74	76	66	0.51	0.44
16.	Non-metallic Chemistry	47	50	0.43	0.49	54	60	0.36	0.40
17.	Organic Structure	77	83	0.74	0.81	93	129	0.62	0.86
18.	Particulate Nature of Matter	80	89	0.78	0.88	95	94	0.63	0.63
19.	Nuclear Chemistry	70	81	0.71	0.78	90	121	0.60	0.81
20.	Laboratory Techniques	49	53	0.46	0.50	50	51	0.33	0.34

* 1986/87 Test Scores for 100 students

** 1987/88 Test Scores for 150 students

TABLE IV

t-Test Results on Test Scores

Session	N	Mean Score	SD	Df	t	Table t
1987/88	150	Pre-test=63.6 Post-test=69.3	24.2 31.3	149	3.34*	At 5%=1.96 At 10%=1.65
1986/87	100	Pre-test=57.3 Post-test=61.8	12.8 19.0	99	3.48*	At 5%=1.96 At 10%=1.65

*The t value for each session shows that some significant differences exist between the mean of pre-test and post-test.

employing t-test statistics at both 0.05 and 0.1 within the relevant degrees of freedom. The results are presented in Table IV.

Results and Discussion

The present study was undertaken with a view to identify chemistry concepts which were not well understood by remedial entrants during their post-primary chemistry programme; and also to provide the remedial chemistry instructors with areas that needed in-depth treatment and appropriate emphasis during the teaching-learning process. After incorporating any identified difficult concepts into a modified teaching- learning scheme, it was expected that there would be a general improved performance in the terminal course examination in chemistry.

The average difficulty index for every two multiple choice items asked of each concept is presented in Table III. The mean scores and standard deviation together with t-values are presented in Table IV.

The test concepts and response patterns as presented in Table III show that the difficulty indices for test concepts on separation and purification of substances, periodic table and bonding, energy changes, metals and their compounds, organic structure, particulate nature of matter, and nuclear chemistry fall between 0.70 and 0.95 for both pre-test and post-test during the 1986/87 session. It may be inferred that some of the test items on these concepts were relatively easy. During the 1987/88 session the remedial entrants again passed well on the concepts of separation and purification of substances, organic structure, and nuclear chemistry with the difficulty indices ranging between 0 60 and 0.93 for the pre-test and post-test scores.

The difficulty indices for concepts like chemical combinations, gas laws, chemical measurement, oxidation and reduction, chemical equilibrium, non- metallic chemistry, and laboratory techniques during the 1986/87 session ranged between 0.46 and 0.65. This signifies that the included concepts were in the middle range of difficulty; and would clearly not discriminate between those who did well and those who did poorly on the particular test item. The performance of the 1987/88 entrants on the listed concepts was generally poor as judged from most of the difficulty indices that ranged between 0.10 and 0.45. While these concepts challenged the abler students, each test item on these concepts may need to be restructured to provide for the reasoning ability of the average student.

Generally it can be inferred that more than 50% of the concepts tested by this instrument were found difficult by the remedial entrants of the 1986/87 and 1987/88 school years. These included chemical combinations, kinetic theory of matter, gas laws, chemical measurements, water, solubility, acids-bases-salts, oxidation-reduction, electrolysis, rates of reaction, chemical equilibrium, non-metallic chemistry, and laboratory techniques.

TABLE V

Course Performance on Identified Difficult Concepts During 1987/88 Session

	Concepts	%age Passing Each Concept at Credit Level*
1.	Chemical Combination	60
2.	Kinetic Theory of Matter	55
3.	Gas Laws	56
4	Chemical Measurements	70
5.	Water	68
6.	Solubility	65
7.	Acids-bases-salts	50
8.	Oxidation-Reduction	56
9.	Electrolysis	40
10.	Rates of Reaction	60
11.	Chemical Equilibrium	67
12.	Non-metallic Chemistry	70
13.	Laboratory Techniques	45

*Pass at Credit Level means a score of 50% and above.

The results in Table IV indicate an overall significant difference in the mean scores of the four treatment groups. The t-test statistical analyses signify that the response pattern to the test is peculiar to each set of entrants in a particular year.

It seems that the identification of concepts which were not well understood by students, and teaching the identified concepts with appropriate treatment and emphasis increased students' ability to comprehend and apply any acquired chemical information. The 1987/88 course examination results in Table V indicate a general improved performance on the identified difficult concepts.

Significance of Study

The University of Cross River State admits 80 per cent of her indigenous students mainly from schools around the state for the remedial science programme. Thus, the results of this investigation was taken as a representative of the complete range of schools in the Cross River State and a partial range of schools in Nigeria.

The degree of accuracy of students' pre-test and post-test performance formed the basis of identifying the concepts which were not very well understood by students. The identified difficult concepts provided the remedial chemistry instructors with areas that needed in-depth treatment and appropriate emphasis during the teaching-learning process It was hoped that the study might foster dialogue between secondary school and university teachers. Such a dialogue may be helpful in the reorganization of the time allotments that one assigns to each topic. Moreover such forum may generate other basic information so that further data could be gathered and other studies conceived to improve instruction in remedial chemistry.

Conclusion and Recommendations

Wiseman (1981) has stressed that "the combination of factual material, mathematical calculation, and theory that constitute modern chemical knowledge contribute toward making chemistry one of the most intellectually demanding subjects in the university or high school curriculum". This study obviously found that some chemistry concepts in the secondary school curriculum are giving difficult time to students during the teaching- learning process. For the concerned chemistry instructor, areas where more emphasis is needed or a more thorough review of fundamentals is required have been identified. The study should be repeated to include other relevant chemistry concepts. The cumulative result of such study should help to establish a set of objectives that would encompass those ideas or concepts of chemistry which should be required by every student completing a secondary level chemistry course.

There is need to determine the kind and level of academic skills that are essential to th mastery of specific concepts in the various science disciplines. A similar research is needed in the areas of biology and physics as well as mathematics. It is hoped that such work would contribute to the smooth continuation of science work when students transfer from the remedial programme to the regular university courses.

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Computing - 2: Preliminary Instructions and Symbols used in KDF 9 ALGOL, FORTRAN IV and BASIC

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In the previous article 1, we have discussed about the basic features of the three well-known computer languages, viz., KDF 9 ALGOL, FORTRAN IV and BASIC as well as the uses of integers, decimal numbers, variables, mathematical operators and arithmetic expressions in these three languages.

In the present paper, we shall discuss about the uses of relational operators, standard functions, assignment symbol, subscripted variables, input-output instructions and various other non-ecutable statements.

Use of Relational Operators and Standard Functions

The different relational operators used in d ferent languages are given below:

Name of the Operators	Use in KDF 9 Algol	Use in Fortran IV	Use in Basic	Use in pseudo language
Equal to	=	.EQ.	=	=
Not equal to	≠	.NE.	<>	≠
Less than	<	.LT.	<	<
Less than or equal to	≤	.LE.	<=	≤
Greater than	>	.GT.	>	>
Greater than or equal to	≥	.GE.	>=	≥

The different standard functions used in different languages are given in the following Table.

We can replace x by any arithmetic expression in all the functions mentioned in the Table.

Assignment Symbol in an Arithmetic Statement

In algebra, we very often use an equation of the type $z = x + y$. This describes a relationship between the variables z, x and y. Once the values of x and y are given, we can easily compute the value of z. In Fortran IV, this arithmetic statement is written as $Z = X + Y$ and in KDF9 Algol

Functions	Description	Use in KDF9 Algol	Use in Fortran IV	Use in Basic	Use in a Pseudo language
e^x	exponential	exp(x)	EXP(X)	EXP(X)	EXP(X)
$\log_e x$	natural logarithm	ln(x)	LOG(X)	LOG(X)	LOG(X)
$\sin x$	trigonometric sine	sin(x)	SIN(X)	SIN(X)	SIN(X)
$\cos x$	trigonometric cosine	cos(x)	COS(X)	COS(X)	COS(X)
$\tan x$	trigonometric tangent	tan(x)	TAN(X)	TAN(X)	TAN(X)
$\cot x$	trigonometric cotangent	cot(x)	COT(X)	COT(X)	COT(X)
$\sin^{-1}x$	inverse of sine	are sin(x)	ARSIN(X)	ARSIN(X)	ARCSIN(X)
$\sqrt{x}$	positive square root	sqrt(x)	SQRT(X)	SQRT(X)	SQRT(X)
$\lvert x \rvert$	absolute value	abs(x)	ABS(X)	ABS(X)	ABS(X)

and Basic, this statement is written respectively as follows:

$z = x + y$

and LET $Z = X + Y$

In pseudo language, we shall use this statement as

$Z \leftarrow X + Y$

The symbols =, := and ← used above are called assignment symbols. Each of these symbols should be read as "is to be replaced by" or "is assigned the value of" or "becomes" rather than "is equal to" or "is equivalent to". The arrow from right to left implies fetching and transferring the value of $X + Y$ from the appropriate memory location of a computer to the storage register designated by Z via the accumulator in the arithmetic unit. The assignment instruction permits a programmer to move data from one memory location to another. Since the current value transferred to a storage location automatically replaces the old or previous value, the above statement is also called replacement statement. We should remember that the symbol "=" in an arithmetic statement does not indicate the sign of equality as in Mathematics. This is clear from the statement $J = J + 1$. This does not clearly represent an algebraic equation, because in that case $J = J + 1$ implies 1=0 which is absurd. In programming languages, this statement means that we should replace J by the current value of $J + 1$.

We note that in BASIC only, we use a keyword "LET" before this statement.

There are some restrictions in the use of arithmetic statements using assignment symbols. This should be carefully remembered. On the left side of the assignment symbol ←, = or: =, only a single variable name and not an arithmetic expression involving addition, multiplication, etc. are allowed. Thus $X + Y \leftarrow Z$, $X + Y = Z$, or $X + Y := Z$ is an invalid statement. Of course, one can write any arithmetic expression on the right side of the assignment symbol. Thus $J \leftarrow J + 1$, $J = J + 1$ or $J := J + 1$ is a valid statement.

Subscripted Variables

In Mathematics, we often use variables with subscripts, single or double, e.g.,

$a_1x_1 + a_2x_2 + a_3x_3 + .. \; a_nx_n = 0$

or $a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \ldots a_{14}x_n = 0$

The former equation involves variables with single subscripts and the latter involves those with double subscripts.

In Fortran IV or Basic, the subscripted variables are written as

A (1), A (2) etc.

or A (1,1), A (2,3), etc.

and in KDF9 Algol, these variables are written as a[1], a[2], etc.

or A[1,1], a[2,3], etc..

The general form of a subscripted variable in KDF 9 Algol is

A [Sub, Sub, ... Sub]

where "Sub" stands for a subscript which may be any arithmetic expression. If this Arithmetic Expression (AE) is not an integer, then the largest integer not greater than AE +.5 is taken as the value of the subscript (i.e., the nearest integer).

In Fortran IV, a subscript can only be a non-zero unsigned positive integer or an arithmetic expression of the form variable ± constant or constant* variable ± constant The arithmetic expression should be such that it must be a positive integer. Thus in Fortran IV, the subscripted variables

A (1+2, 1-3, 2*J, 4*K+3, 8*J-4) are valid but

A (2+I, -3+I, I*2, K*4+3, J*8-4, +5, I*K) are invalid.

In Basic, any arithmetic expression can be used as subscript as in KDF9 Algol, but if the arithmetic expression has a non-integral value, then the digit after the decimal point will be truncated and only the mantissa part (which must be non-zero positive) will be taken (In KDF9 Algol, the nearest integral value of the arithmetic expression will be taken as the value of the subscript). In case the value of the arithmetic expression becomes zero or negative in any of the three languages, then an error message will be written by the computer and the programme execution will be terminated.

When the subscripted variables are used in a programme written in Fortran IV, a Dimension statement is required to inform the compiler that a particular variable is a subscripted variable so that the required amount of storage is allocated to the variable.

In KDF9 Algol, an Array declaration in place of Dimension statement is necessary. This Array declaration indicates the lower and upper bounds of the subscripts. Whether the elements of the array are real or integer are also to be declared in KDF9 Algol. If no type declaration is there in the programme, then the elements are taken as real only.

In Basic, no such declaration is necessary. In pseudo language also, we shall not be bothered about these declarations and we shall follow the rules of Basic to use subscripted variables.

It can be mentioned here that subscripted variables can be used in assignment statement as follows:

$A(I) \leftarrow A(I) + B(J)$

$TEMP \leftarrow A(J)$

Input and Output of Data

The input statement is used to enter numerical data into the computer during programme execution. The key words used for input statement are "INPUT" in BASIC and "READ" in FORTRAN IV together with a list of variables separated by commas. Note that a comma after "READ" is necessary in FORTRAN IV.

For example, INPUT A, B, C in Basic and READ, A, B, C in Fortran IV.

It should be remembered that the data items must correspond in number and in type (real or integer) to the variables listed in the INPUT or READ, statement. Any extra data items will be ignored by the computer. The data items must be separated by commas.

The input statement used in KDF9 Algol is of the type: read (DV)

where DV stands for some device number. This device number is any number between 20 to 27 if the data are supplied in paper tapes and any number between 40 to 47 if the data are supplied in cards.

For example, if the values of three variables A, B, C are supplied in paper tapes, then the input statement in KDF9 Algol will be as follows:

A:= read (20); B:=read(20); C:= read (20);

Note that in KDF9 Algol, after each statement there must be a semicolon and variables in both small and capital letters can be used, but the keyword "read(20)" must be written in small letters.

In pseudo language, we shall use the following input statement

"get A, B, C"

We agree to write the keyword in small English letters.

The output statement is needed after the programme is executed. After the completion of the programme the results of the computation are to be transferred from the memory of the computer to one of the several output units. This is done by the output statement.

In Fortran IV and Basic, the output statements are respectively as follows:

PRINT, A, B, C

PRINT A, B, C

The output statement in KDF9 Algol is of the type Output (DV, AE)

where DV stands for a device number and AE stands for an arithmetic expression. The output device number in paper tape punch is any number between 10 to 17.

For example, output (12, a-b); output (10, k [1, p]), are valid output statements.

In pseudo language, we shall use the following output statement:

"output A, B, C".

The "Format" Statement in the Output of Data

This statement specifies the external appearance of the output data. A FORMAT STATEMENT contains specifications, conversion codes or field descriptors. The layout of data provides a picture of the number which is to be printed. It shows where digits, zeros, spaces, sign, decimal point and the exponent are to be printed in the output field. It may also call for a new line or new page on the output medium or print a semicolon to separate one number from the next. This makes the output statement particularly in KDF9 Algol very versatile.

In KDF9 Algol, the output statement using FORMAT statement is of the type:

Write (DV, FE, AE)

where DV stands for output device number, FE for Format expression and AE for arithmetic expression.

Since there is no provision for FORMAT statement in simple Basic and pseudo language, we shall not describe the rules for FORMAT expression used in KDF9 Algol and Fortran IV.

Since a FORMAT statement is informative in nature, it is non-executable. In other words, this statement does not direct the computer to perform specific operations. It merely guides the compiler to enable it to translate the executable statements correctly into machine language. Henceforth we shall write all programmes in these languages using FORMAT free statements

Initialisation and Closure of Input and Output Devices in KDF9 Algol

In KDF9 Algol, before each input statement like "x: = read (20)", one must write "open (20)" and then "close (20)". Similarly, after the output statement like "output (10, a-b)", one should write "close (10)" at the end of the programme. These statements are required in order to allocate and deallocate actual devices corresponding to those called by the ALGOL programmer and inform the operator of the choice for purpose of loading and unloading tape reals, etc. These statements are not required in other languages.

Statement Labels

Any statement may be labelled by a statement number. In Fortran IV and Basic, a statement number is any positive non-zero number between 1 and 99999. It must be unsigned. In Basic, it is essential that each statement must have a statement number and the successive statements must have increasing statement numbers. But in Fortran IV, it is not necessary that each statement must be preceded by a statement number. Further, the statement numbers may be taken as any order, increasing or decreasing or mixed.

In KDF9 Algol, the statement number is denoted by a variable name and not by integers.

In pseudo language, the labels, if necessary, are chosen just like in Fortran IV.

Stop-end or Begin-end Statements

The STOP statement used in Fortran IV terminates the execution of the programme and it actually stops the computer. The computer cannot be inserted later on to resume work on the same programme. This statement can be labelled also. It is written as

STOP

in Fortran IV.

After the STOP statement, the END statement is written in Fortran IV. The END statement indicates the physical end of the entire programme. The STOP programme only signifies the logical end of the programme. The END statement is non-executable and so it should not be transferred to this statement. This statement is written in Fortran IV as

END

In Basic, only END with a statement number is written at the end of the programme and no STOP statement should be written before this statement Since this is the last statement in the programme, its statement number is the highest.

In KDF9 Algol, we write the underlined word begin at the first line of the programme and the word end at the end of the programme. All statements must lie within begin and end statements. All statements bounded by the keywords begin and end form what is called a block.

In a pseudo language, we shall prefer to write only stop at the end of the programme.

Comment Declarations

The COMMENT declaration identifies the programme, gives details about the method used and may include the programmer's name.

Any sequence of basic symbols can be used after the COMMENT declaration. These are completely ignored by the computer while the programme is executed. So its inclusion in a programme is optional, because it has no effect on the execution of the programme. One should, however, be brief in writing something after the keyword COMMENT. This declaration can be made anywhere in the programme. In Basic, we use the keyword REM meaning Remark in place of COMMENT but its functions are exactly the same as stated above. It should also be labelled in Basic. In KDF9 Algol, we write this declaration as comment. It must be underlined. In Fortran IV, it is denoted by the letter C. In pseudo language, we shall use it as in KDF 9 Algol.

Bird Migration

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After more than 2000 years of observations, climaxed by a century of experimental studies, we are still not certain regarding many facets of migration We have considerably authentic data on breeding range, wintering quarters and many migratory routes of a large number of birds but we still are not in a definite stage to explain why birds go where they do at the time they do, and their manner of navigation is only partially understood.

Introduction

One of the most spectacular events in the animal world is the migration of birds — the feathered bipeds. It has intrigued mankind for many centuries. It led to such wild speculations that the swallows hibernated in the mud and that some birds flew to the moon for winters. Continuous observations and experiments have dispelled some of these fanciful notions about the life cycle of birds but still many more years will be required to ascertain how and why of the migration. Most of us in India, have also noticed the great influx of birds during September to November. The trigger-happy hunters shoot the snipe, geese, teals, ducks, etc., during winter for their table. During the annual royal shoots, thousands of such migratory birds were hunted by the rulers and their guests. In Bharatpur, 4273 ducks were shot on 12th November, 1938 by Lord Linlithgow, Viceroy of India, along with his 38 gunmen in a single day while 10437 Imperial sandgrouses (migratory birds) were massacred by King Sardulsinghji of Bikaner, on two days in February 1929 at Gajner.

Larks, leaf-warblers, wagtails, pipits, etc., all seem to pop up suddenly in winter from nowhere. Only a few of us have ever bothered to know as to why this event takes place year after year. Many only think that the birds move because it is in their nature to do so; from where they come, does not concern them and why and how they do it, is clearly the birds' own affair. The migration of birds has been so regular and definite that the Red Indians of Fur countries named their calender months after the arrival of the migratory birds.

Migratory Movements in Other Animals

Apart from aves (birds), many other animals also show migratory movements. Certain insects, particularly butterflies, undertake regular migration; some going south for winters. Sharp periodicities in the breeding cycles of most of the amphibians involve short journeys to and from water source. Many reptiles travel for suitable winter quarters. Among the fishes, the amazing migrations of the eels and salmon are well known. Among mammals, the cyclic outbreaks of lemmings (a small arctic rodent like rat) are classic; the lemmings, at an interval of 3 to 5 years, reach population peaks, apparently compelling them to practise death migrations, sometimes drowning in sea.

Basis of Bird Migration Knowledge

The present state of modern knowledge of the bird migration, although still far from perfect and complete, is based on the following six sources:

(i) Extensive data available on the distribution of many species in many countries.

(ii) Direct observations of visible migration by day or of resting birds, at favourable localities.

(iii) Nocturnal observation of birds attracted to lighthouse and lightships; attraction to light in particular period (Jatinga in North-East India), or heard (calling over of geese overhead in autumn and spring) or seen by telescope while crossing face of the moon (moon watching in America).

(iv) Observation of migrants (day or night) by radars.

(v) Ringing of individual birds by bands of metal or plastic.

(vi) Experiments on birds especially on premigratory restlessness (development of a particular metabolic or physiological condition called Zugdisposition by Europeans.)

Definition

Migration in a broad sense as defined by Cahn (1925) is "a periodic passing from one place to another". The most commonly accepted definition now is "Regular movement of birds between ALTERNATE areas inhabited by them in different times of the year, one area being that in which the birds breed and the other being an area better suited to support them at the opposite season." A. Landsborough Thomson, an eminent ornithologist, describes Bird Migration as "Change of habitat periodically recurring and ALTERNATING IN DIRECTION which tends to secure optimum environmental conditions at all times." It is the back and forth movement that is the crucial feature of bird migration. The periodic invasion of locust swarms (tiddi-dal) is not migration for they do not entail a return to the starting point; it is just an overflow movement. Thus march of locust army differs markedly from the seasonal return traffic taking place in birds According to celebrated ornithologist Padma Vibhushan lata Dr. Salim Ali — Father of Indian Ornithology — the 'Pendulum-swing' movement is noticeable in some other groups of animals as well, but it has reached its rhythmical climax in birds.

Nature and Extent

Most of the birds migrate, some may go only a few thousand metres while others may travel thousands of kilometres. The longest migratory journey is performed twice in a year by the Arctic Tern, *sterna macrura*; it migrates in winter from the Arctic and goes south right across the world to, Antartic summer and back again, the distance being 17,600 kms one way. It breeds up to 82°N latitude and reaches 75°N latitude in its off season. Some birds in the high altitudes are sedantry, i.e., they do not migrate. The birds that stay during their migratory journeys at a definite place are known as true migrants while those passing at a place in autumn or spring are termed as autumn or spring passage migrants respectively. Some birds breeding in high Himalayas in summer have to come down to valleys or foothills to escape severe winters and the descending snow line. There is an exception to it. In Dead Sea area, some birds breed in hot valley about 300 m below sea-level and come to adjacent hill country during winter. It is also another exception to the axiom of Nature that the birds always nest and breed in the colder portion of their migratory range.

Advantages of Migration

As seen above, migration involves occupation of two different areas by the bird, at the respective season, favourable in each. It implies a swing from a breeding or nesting niche in the bird's home to a feeding or resting place in its winter quarters The absence from high altitudes during the cold winter weather enables the bird

1. To escape cold and stormy weather.
2. To tide over conditions reducing availability of food (due to freezing of water and covering of feeding grounds by snow).
3. To avoid short day-light hours for searching food.

Similarly, return to the high altitudes in the summer hot weather provides the distinct advantage of

1. Making available large uncongested expanse of land for nesting.
2. Abundant food supply due to luxuriant growth of spring plants.
3. Giving longer hours of day-light for searching food so much needed for the young ones.

Migratory Routes

The migration, in its more extensive form, essentially means a change in altitude; the general trend, therefore, is north to south. It is often considered that the birds take straight and definite routes.

Maps suggesting migration routes based on the recoveries of ringed birds could also be misleading, particularly when they are banded and captured only at their breeding and wintering centres or vice-versa. Birds ringed in Bharatpur have been recovered in U.S.S.R. in their breeding zone and if this is joined by a straight line or linking line, it gives, what is known as, 'Primary Direction'. The actual migratory route is, however, far from straight and is often modified according to feeding ground, weather conditions and topographical features Occasionally, the birds take a curve and at times they even take a totally opposite direction for a while. Migratory routes can be differentiated in narrow or multiple flyways. Narrow route is rather uncommon and only a few birds adopt it. Some storks use a long and narrow flyway through Eastern Europe and near east due to their aversion to cross wide sea.

Most of the birds prefer to take multiple flyways spreading over a wide area; the width varying with the species of bird and the local conditions At certain places, these multiple airways may converge due to narrow territory where migrants get funnelled down in dense concentrations. As the passage broadens, the migrants spread once again Many migrants like to follow low contour routes, rivers, valleys to enjoy flying conditions. Certain tracts strongly repel some birds Land birds specially passerines (sparrows etc.) hesitate to cross wide waterways. In certain cases, on reaching shore, they feel reluctant to proceed further and change the course, temporarily, to fly along the shore (land) just to delay the inevitable. Sometimes islands lure the birds. Terrestrial birds, after crossing the sea, between the Netherlands and Frision island fly east west but change the direction to fly along the entire length of these islands. This phenomenon is seen with many birds of Andaman and Nicobar island groups. Land repels sea birds and many sea birds like gulls change their route to avoid land although they could save time and energy. Many birds, however, do not get deterred by the territory over which they fly. Lesser Black-headed Gull from Baltic, crosses the entire Europe to reach Mediterranean Sea and some even proceed to East Africa, crossing the desert. Many ducks and geese cross over the Himalayas from Central India such as Mallard, to winter in various parts of north India. The major migration from and to the northern lands (Central Asia, Siberia, Mongolia, etc.) in autumn and spring each year takes place at both ends of the Himalayas, mainly through Indus and Brahmaputra valleys. The migrational stream of land birds converges down the two sides of Penninsula to Ceylon forming the terminal as redstart, buntings etc.

Flight

Birds exhibit astonishing feats during the migrational sojourns.

Speed: Migratory flights are, of necessity, faster than the normal flight speed. Although, it is difficult to measure the speed due to wind, etc., some speeds have been worked out as below:

Hawks (like Sparrow, Besra) fly at 50 to 65 kms/hour while waders (ruff and reeve, lapwings, curlew, etc.) cruise at 65 to 80 kms/hour; the ducks (pintails, shovellor, pochards, etc.) and geese (gray lag, bar-headed, etc.) fly at 80 to 100 kms/hour.

Duration: A bird's flying day or night stretches over 6–11 hours, and migrants cover long distances in this manner and then they come down to rest and feed. Some interesting features of a single hop of birds are 1. Coot – 250 kms; 2. Stork – 240 kms; 3. Wood-cock – 450 to 480 kms; 4. Plover (Golden plover) – 880 kms (with the flying period of 11 hours).

Birds migrate by day or night and are termed as diurnal or nocturnal respectively. Most of the smaller birds, essentially insectivorous like bee-eaters, fly-catchers migrate at night so that, in day, they may catch insects as well as take rest. Small song-birds as thrushes, larks, etc., are also nocturnal. Swallows and swifts, which feed on wing, migrate by day. Hawks, rollers and most of the birds of prey (falcon, harriers, eagles, etc.) also are diurnal. French ornithologist Jean Dorst (1962) says "in some instances, the migrants must cover long distances without a break. Land birds flying from Scandinavia to Great Britain fly 220 to 400 miles non-stop. The Eastern Golden Plover (*Pluvialis dominica fulva*) makes its 2400 miles trip non-stop from Nova Scottia to South America in about 48 hours. This bird lives in West Alaska and North East Siberia and is a regular visitor to Hawaian island." This plover is also a winter visitor to India. The snipe — *Capella hardwickii* which breeds only in Japan and spends winter in Eastern Australia and Tasmania must habitually fly 4800 kms non-stop over the sea because it has never been seen in between.

Distances: Long distance flier in India is the wood-cock (*Scolopax rusticola*). It breeds in the Himalayas and winters in the Nilgiris and other hills of South India and since this has not been recovered or seen anywhere, it must travel at least 2400 kms non-stop. A knot, *Calidris canutus*, ringed in England was recovered 7 days later in Liberia at a distance of 5600 kms. Similarly a Ruff and Reeve with the ring number B 4223 of Bombay Natural History Society, ringed in Bharatpur on 9.10.67 was recovered in May '68 in Yakutian (USSR) at a distance of 5850 kms.

Height: It was thought that the birds in their migratory flight always flew at high altitudes but recent studies show that the night flights are made at low elevations; generally at 1000 m above M.S.L. and on the cloudy nights, the birds fly at very low heights. Birds flying along sea habitually remain low because the obstacles are rather non-existent. There are many birds whih fly every high. A Mallard (Nilsir — *Anas platyrhynchos*) got killed by an aircraft at an altitude of 6437 m. Lapwings are known to cross mountains at 2590 m, while cranes at 4572 m. The highest recorded altitude at which the birds migrate is probably of geese (*Anser* spp.) crossing the Himalayas at 8839 m; almost equal to the Mount Everest height. Crow like bird, chough, followed Sir Edmund Hillary up to 7772 m to 8200 m during his ascent to the Mount Everest in May 1953. The Everest expedition also met the birds like crows, griffon vulture and mountain finches at 6400 m to 7000 m. The observations with the help of radars have shown that birds migrate at 7500 m in large flocks, without there being any.

apparent physical compulsion for them to take such heights. In spite of the numerous observations, studies, etc., we are still conjecturing on the migration aspects of the birds.

Orientation

We are still probing in the dark as to how the birds orient themselves during migration. It is, however, now agreed that the birds can orient themselves by sun in the day and by stars and moon in the night. Cloudy day or night often mislead the migrants. Generally the migratory flights commence before night fall or in the early morning supporting the theory of sun orientation. In Bharatpur, it has been regularly noticed that the migratory geese and ducks come in long V-shaped fashion and even the cormorants on their daily feeding flights outside the Keola Deo National Park in Bharatpur move in a V formation. Pelicans and Siberian cranes fly spirally over this park, giving loud calls to collect their group members before migrating away.

Number in Migration

Some birds may migrate individually like birds of prey or in a scattered association but they continue their touch with each group by yelling frequent calls. Other birds like ducks, geese, passerines, shore birds move in close formations. It was noted that all the Greater Snow Geese, 70000 in number, stopped in a strip of marsh along St. Lawrence in 1957 on their journey to Atlantic coast.

Punctuality of Migrants

A few birds are very specific in selecting their breeding site year after year. There is the classic example of swallows in Europe, where they rturn to the same locality but even to same nesting site in the same very building every year after covering over 9500 kms each way. In our country, a ringed Wagtail (*Motacilla caspica*) was found to occupy the particular lawn (not bigger than a badminton court) in Greater Bombay on almost the exact date in September for five years continuously. An Orphean Warbler (*Sylvia hortensis*) which was ringed in Saurashtra (Kathiawar) in September one year, was recaptured in the nets on the self- same acre or two in the same month, almost to the date, in the next year and in one case, even in each of the three succesive years. It must, however, be not lost sight of that the regularity and accuracy of return of the migrants is largely dependent upon the availability of food and shelter in that particular locality in that particular year besides the climatic conditions obtaining in the breeding and wintering zones.

Many birds, it seems, are very instinctive as well for they will come to the same place in spite of the impending dangers to their survival, confirming that in crisis, intelligence admits defeat but instinct knows only death. Some chicks which were separated from their parents and did not accompany them to the wintering quarters, also exhibited the instinctive restlessness during the migratory season and some of them did reach the breeding zone and joined their parents

Conclusion

After more than 2000 years of observations, climaxed by a century of experimental studies, we are still not certain regarding many facets of migration. We have considerably authentic data on breeding range, wintering quarters and many migratory routes of a large number of birds but we still are not in a definite stage to explain why birds go where they do at the time they do, and their manner of navigation is only partially understood.

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Experimenting with Pythagoras Theorem

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It is believed that the theorem was also known to Babylonians a thousand years before Pythagoras in the form of calculating the diagonal of a square. But they associated numbers with lines Pythagoras was, perhaps, the first to find a proof of the theorem considering the areas of the sqares on the sides of a right angle triangle.

Everybody, perhaps, is familiar with the extremely important Euclidean Geometry Theorem: "in any right angle triangle, the square of the hypotenuse is equal to the sum of the squares of other two sides" (Fig. 1). This theorem is associated with the Greek Philosopher and Mathematician, Pythagoras who was born in about 580 B.C. in Samos of Greece and later settled in Italy.

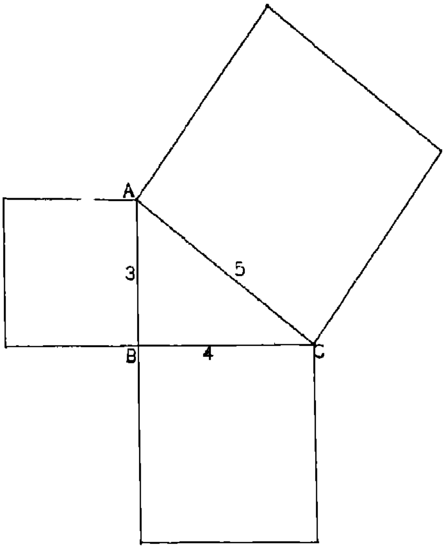

Fig. 1

The ancient Indian Baudhayan's *Sulba Sutras* of 600 B.C. also mentions a similar theorem but in different manner

'dīrghacaturasrasyāksnayārajjuh pārs′vamānī tiryanmānīca yatprthgbhūtekkurūtastadubhayam karoti'

which means — 'The diagonal of a rectangle produces by itself both (the areas) produced separately by its two sides' (Fig. 2).

This information was also characterised by 'knowledge of plane figures' in another ancient Indian text, *Apastamba.*

Therefore, the pythagoras theorem is nothing but the same as described in Sulba Sutras because, the diagonal AC of rectangle ABCD is the hypotenuse of right angle triangle ABC.

It is believed that the theorem was also known to Babylonians a thousand years before Pythagoras in the form of calculating th diagonal of a square. But they associated nu bers with lines Pythagoras was, perhaps, the first to find a proof of the theorem considering the areas of the sqares on the sides of a right angle triangle.

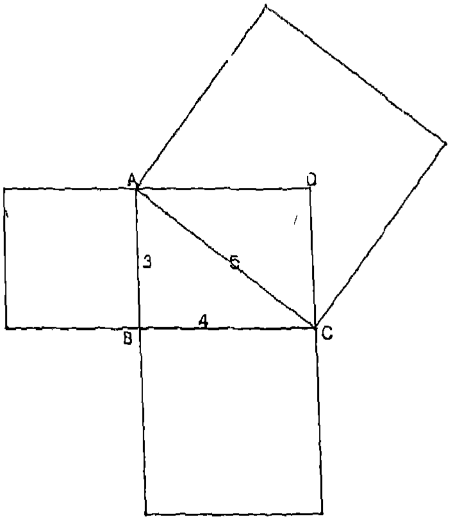

Fig. 2

This theorem, still taught as Pythagoras theorem in School Geometry, has now been proved by a number of methods.

Generalisation of Pythagoras Theorem

Pythagoras theorem, taught for squares on the sides so far, can also be proved for any regular polygons on the sides. Therefore, the Pythagoras theorem or Sulba Sutras' knowledge of plane figures could be generalised as follows:

> "The area of any regular polygon on the hypotenuse of a right angle triangle is equal to the sum of the areas of similar regular polygons on other two sides."

Algebraic Proof

In case of equilateral triangle (Fig. 3(a))

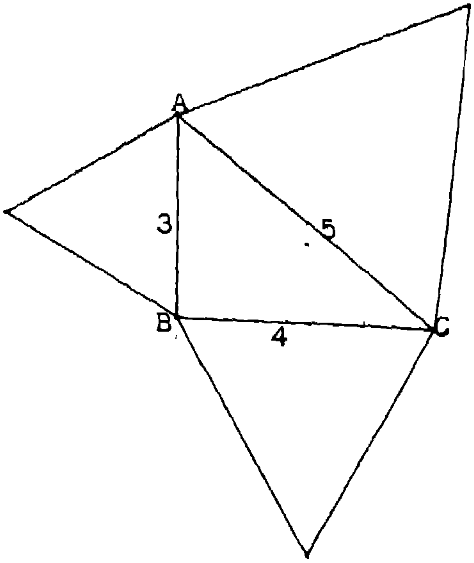

Fig. 3(a)

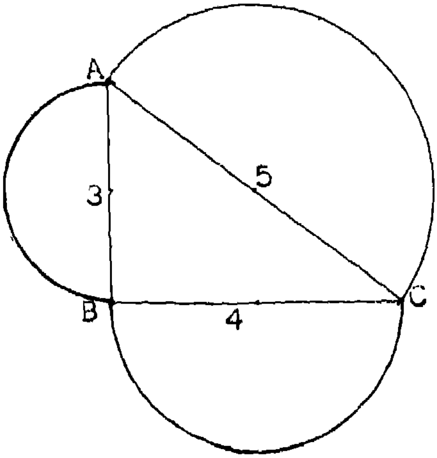

Fig. 3(b)

X = Area of equilateral triangle on

$AC = 25\sqrt{3}/4$

Y = Sum of areas of equilateral triangles on

$AB\&BC = 16\sqrt{3}/4 + 9\sqrt{3}/4 = 25\sqrt{3}/4$

Therefore, $X = Y$ Similarly in case of semi-circle (Fig. 3(b))

M = Area of semi-circle on

$AC = \frac{1}{2}\pi(5/2)^2 = 25\pi/8$

N = Sum of areas of semi-circles on

$$AB\&BC = \frac{1}{2}\pi(\frac{4}{2})^2 + \frac{1}{2}\pi(\frac{3}{2})^2$$

$$= \frac{16}{8}\pi + \frac{9}{8}\pi = \frac{25}{8}\pi$$

Therefore, $M = N$.

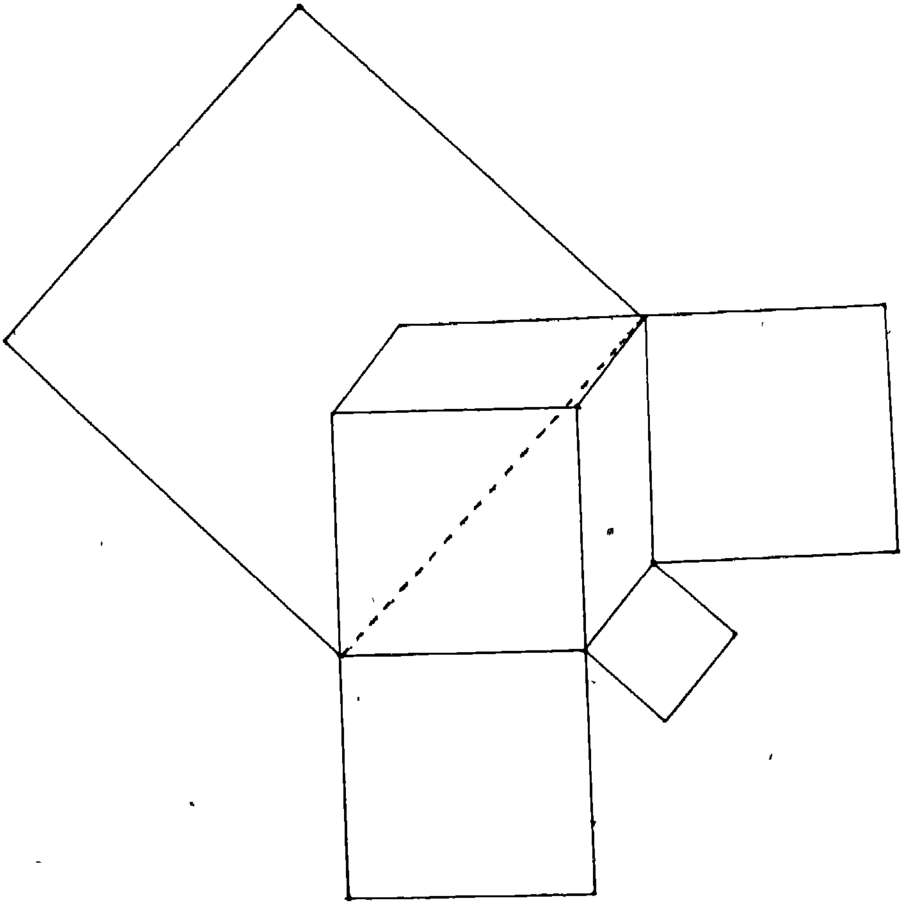

Fig.4

Likewise the theorem can be proved for other regular polygons such as pentagon, hexagon, octagon, etc.

In 3 dimensions also the theorem can be interpreted as 'the area of the square/polygon on the diagonal of the rectangular/cubical lamina is equal to the sum of the areas of squares/polygons on other three sides (Fig. 4)..

Expansion of the Theorem

The Pythagoras theorem is also true for volumes when the 3rd dimension is same for all the constructed solids on the polygons on the sides of a right angle triangle (Fig. 5).

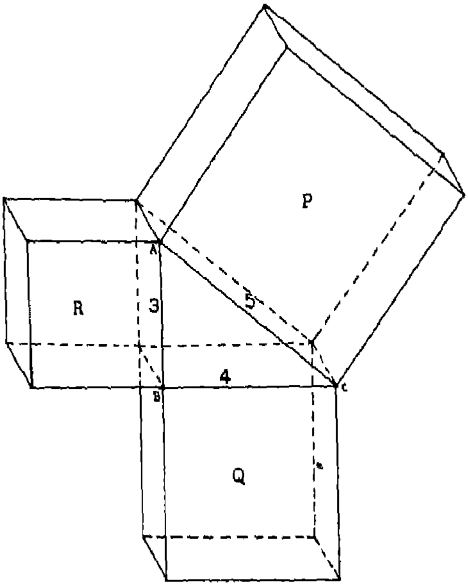

Fig.5

Example

The volume of tray 'P' is equal to the sum of the volume of trays 'Q' and 'R' (depth of all the trays is same).

Proof

Since triangle ABC is a right angle triangle, therefore,

$$AB^2 + BC^2 = AC^2$$

$$m \times AB^2 + m \times BC^2 = m \times AC^2$$

If 'm' be the third dimension (depth) of the trays then the volume of the tray P = volume of the tray Q + volume of tray R. However, the theorem cannot hold true for cubes as:

$$AB^3 + BC^3 \neq AC^3.$$

Therefore, the generalised theorem can be stated as follows:

1. The area of any regular polygon on the hypotenuse of a right angle triangle is equal to the sum of the areas of the similar regular polygons on other two sides.
2. The volume of any regular polyhedron constructed on the regular polygon of the hypotenuse of a right angle tiangle is equal to the sum of the volumes of similar regular solids, having same third dimension that of the solid on the hypotenuse, constructed on the polygons of the other two sides.

Experimental Proof: A Teaching Aid

The common device one thinks for demonstrating the Pythagoras theorem is by using unit squares to show that the number of unit squares required to fill up the square on hypotenuse side is equal to sum of the unit squares required to fill up the squares on other two sides. However, a more effective aid can be made as follows:

Construction

Make a tray of uniform depth as shown in Fig. 6(a). Fix a piece of the central right triangular size ABC on the tray with openings under the triangle at positions shown by dotted lines for

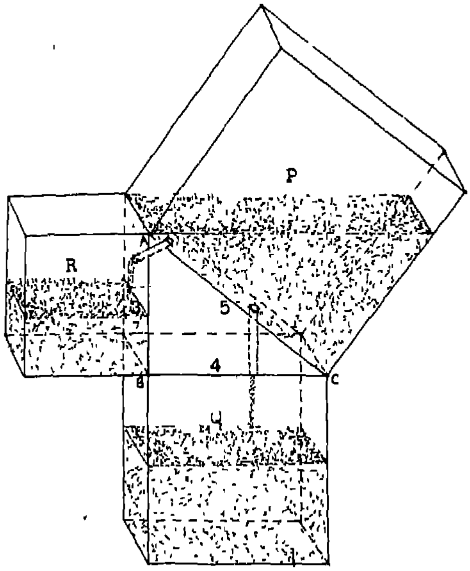

Fig. 6(a)

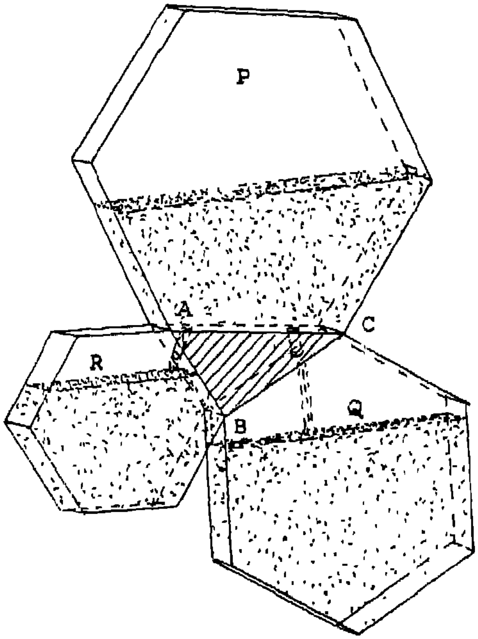

Fig. 6(b)

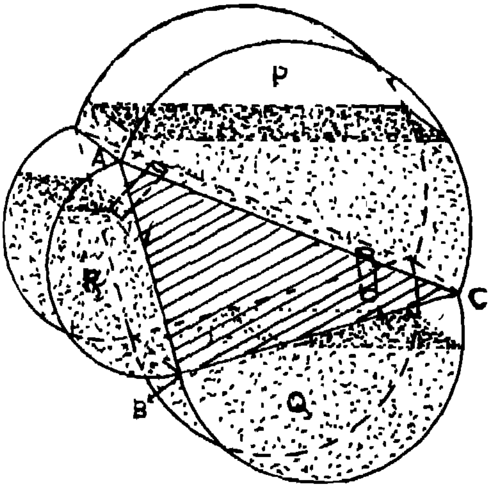

Fig. 6(c)

passage of material (remember the trays P, Q and R are square in shape). Fill up mustard seeds or beads in tray 'P' up to the rim. Now cover all trays by square transparent acrylic pieces, cut to the size, with the help of screws. The aid is now ready for demonstration. Hold the aid with tray 'P' on the top. The seeds roll down to tray portions 'Q' and 'R'. One can observe that the seeds in tray portion 'P' will fill up the tray portions 'Q' and 'R' completely. Similarly the aid could be made for other shapes such as equilateral triangle, semi-circle, hexagon and octagon, etc.

This aid can be made more effective using coloured liquids but the material of the tray and sealing has to be properly taken care of.

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Creativity and Science

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Creativity as an objective might well be achieved by students' writing poetry directly related to facts, concepts, and generalizations achieved in an ongoing science unit

Creative endeavours are needed for students Unique content coming from students emphasizes the learner and the curriculum being integrated, not separate entities. Science curriculum can then make integrated, not separate entities Science curriculum can then make many contributions in guiding creative development for students Pertaining to students making discoveries, Lipman, Sharp, and Oscanyan[1] wrote

> So it is with children The meanings they hunger for cannot be dispensed to them the way wafers are dealt out to communicants at a mass, they must seek them out for themselves, by their own involvement in dialogue and inquiry. Nor is that the end of the matter, for meanings, once found, must be cared for and nurtured, as one might care for one's house plants, pets, or other living and precious treasures But the children who cannot make sense of their own experience, who find the world alien, fragmentary, and baffling, are likely to cast about for shortcuts to total experiences, and eventually may experiment with drugs or succumb to psychoses Possibly we could teach children before they reach out for such desperate remedies by helping them find the meanings so lacking in their lives.

Problem Solving, Creative Behaviour and Science

Students in the science curriculum need to receive quality activities and experiences to achieve the broad goal of revealing creativity in the school and class setting. Creative beings are very much needed in school and in society. Thus problems need identification and novel solutions. The tried and true, as well as the traditional, too frequently do not work in solving vital problems Which learning opportunities might then assist students in science to achieve the overall goal of developing the creative being?

From an ongoing science experiment, students might be encouraged to identify questions and problems Each should be recorded on the chalkboard or transparency Value judgements should not be made as the questions/problems are selected Rather, generating of ideas is salient From the listing, students individually or in committees may select an area to pursue. Students then, with science teacher's guidance, may choose that which is perceived as important. For example, if the performed science experiment pertains to changing selected solids to liquids, students in the ongoing unit could raise questions such as the following:

1. Why do these solids (diverse kinds should be in evidence) change to liquids at different temperature readings?

2. What happens when solids change to liquids?

Questions raised will depend upon the developmental level of the involved student. The above are given as examples. For each question raised, answers need to be sought using diverse reference sources. Students may work individually or in committees to find needed information. With student-teacher planning, the former may have much input into seeking and selecting the reference sources. Experimentation and demonstrations, among other activities, may as learning activities, guide students to find needed answers to identified questions. An open-ended approach is in evidence for students to select reference materials.

From the data gathered, students may brainstorm hypotheses or answers to identified problems. Selected hypotheses may be tested to notice their quality and objectivity. If the hypothesis needs revising, a discussion may follow to make modifications and changes.

Pertaining to experimentalism as a philosophy of education, Ozmon and Craver[2] wrote:

> According to the pragmatists, education should be an experimental enterprise as well as something that assists in social renewal. It should promote a humanistic spirit in people, as well as the desire to explore and find new answers to our present-day problems in economics, politics, and other social life Education should promote our true individualism that will result in a diminishing of our reliance upon custom and tradition in the solving of our problems, and cause us to rely more upon intelligence to achieve our goals and interests.

Dewey pointed out that a "philosophy of education" is not the application of ready-made ideas to every problem but rather the formation of right mental and moral attitudes to use in attacking contemporary problems. Philosophy itself is "the theory of education in its most general phases." When changes occur in social life, we must reconstruct our educational programme to meet these challenges. Thus, our ideas will have a pragmatic function. Learning helps us to meet environmental changes and affects our character as well. In this way, education has a moral influence and should play a vital part in helping us to become the kind of moral persons who are interested not only in promoting our own growth, but also in promoting the growth of others.

Poetry, Creativity and Science

Enjoying and writing of poems can certainly emphasize creative endeavours for students. The science teacher may read orally selected poems to learners relating to the unit being taught. Poems need to be chosen on the basis of the following criteria:

1. Will each poem capture leaner interests?
2. Will students attach meaning to the poem?
3. Will individual differences be adequately provided for?

The science teacher should also introduce selected poems in a stimulating manner to encourage students to read the content on their own A bulletin board display of poems, attractively arranged, may well encourage students to do more reading of poetry related to the ongoing science unit.

Readiness experiences for poetry writing may come from experimentation, audio-visual presentations, and/or reading activities in the science curriculum. Types of poems which students may write include:

1. couplets — two lines with ending words rhyming.
2. triplets — three lines with rhyme in all words at the end of each line.

3. quatrains — four lines with diverse patterns of rhyme, such as lines one and two, as well as lines three and four rhyming.
4. limericks with rhyme in lines one, two, and five, as well as in lines three and four.

The above named poems contain rhyme. Free verse contains no rhyme and does not adhere to any specific number of lines needed within the poem. Also, students with science teacher assistance need to be introduced to writing poems emphasizing syllabication when readiness is in evidence. The following poems may then be read to and written by learners in ongoing science units:

1. haiku with its five, seven, five syllables for each of three lines of verse.
2. tanka with its five, seven, five, seven, and seven syllables for each line of poetry.
3. cinquain with its two, four, six, eight, and two syllables respectively per line in a poem five lines in length.

To emphasize enthusiasm in the writing of poems in the science curriculum, students should experience

1. onomatopoeia or echoic sounding words in the *written product.*
2. alliteration, another poetic device, emphasizing two or more sequential words starting with the same phoneme or sound.
3. imagery in which creative comparisons are made, such as "the moon looks like a smiling face." Here *moon* is creatively compared with a *smiling face*. The word *like* connects the two above italics words. If the words "like" or "as" make the connections, a simile is in evidence. Otherwise, the creative comparison is a metaphor, e.g. the moon is a smiling face above.

Creativity as an objective might well be achieved by students' writing poetry directly related to facts, concepts, and generalizations achieved in an ongoing science unit.

Prose, Creativity and Science

Students should experience prose from selected library books directly related to the present science unit being taught. An interesting type of prose for teachers to introduce and read to learners is tall tales. Readiness activities are then being provided students to read tall tales.

Inductively, students can generalize as to what makes for a tall tale. The following are its characteristics:

1. a superhuman being is necessary. Paul Bunyan and Pecos Bill in American tall tales exemplify the superhuman concept.
2. the superhuman gets into one or more difficult situations.
3. the superhuman being is able to get out of the prescribed difficulties.

Students could take a famous scientist and develop a related tall tale. Students need to be imaginative, possess openness to new content, like being playful with ideas, exhibit tendencies of fluency of thought, as well as pursue a poem to its completion in writing.

Writing tall tales presents opportunities to the student to relate the science curriculum to a truly open-ended kind/type of creative endeavour.

Art Work in Science

Creative experiences may certainly be emphasized in correlating science and art. The writer when supervising a student teacher in the public schools observed a well done mural or prehistoric life, a science unit. The student teacher developed, planned, and implemented the unit in science. One activity emphasized a committee of sixth grade pupils developing the prehistoric life mural utilizing a variety of art media. In the mural, students portrayed the following sciences:

1. a tyrannosaurus rex dinosaur attacking a stegosaurus.
2. a brontosaurus situated in a body of water eating plants.
3. an archeoepteraux flying overhead.
4. fern plants growing in abundance.

Pupils with student teacher guidance evaluated the mural in terms of:

1. effort put forth by each learner.
2. input from all committee members in developing and completing the mural.
3. new ways of presenting subject matter in art form.

Prior to developing the mural on prehistoric life, the science teacher:

1. showed and discussed a related filmstrip.
2. presented and appraised illustrations
3. provided readiness for students to read from their basal science textbooks. Facts, concepts, and generalizations secured by learners were discussed with teacher leadership.

Additional art project developed by committees in the unit on prehistoric life were the following.

1. papier maché models on the diplodocus and the anklasaurus
2. clay models of duck billed dinosaurs.
3. a diorama containing a three dimensional scene, in an enclosed box with the front open, showing diverse dinosaurs with a natural environment for its day in prehistoric times.

Students need encouragement and reinforcement to develop feelings of creativity and spontaneity.

Creative Dramatics and Science

Numerous opportunities are available for learners to participate in creative dramatics in ongoing science units. In a unit on "Famous Scientists," the science teacher needs to guide students to secure background information pertaining to famous scientists being studied. Reading and audio-visual activities should provide readiness experiences for learners.

Students may then be divided into committees. Each committee needs to plan roles for members to play as famous scientists being studied in the ongoing science unit. Famous scientists to be included in the unit and from which students individually will have parts for the creative dramatics presentation could include

1. Louis Pasteur
2. Anton Leuwenhoek.
3. Joseph Lister
4. Sabin and Salk
5. Pierre and Madame Curie.

The above named scientists are given as examples Goals need to be clear for students to achieve in creative dramatics. Background subject matter obtained and the creative dramatics presentation in and of itself need to be appraised in terms of stated goals Students should be involved in self- evaluation endeavours Creativity is the major goal for students to achieve in the dramatic activity. At the same time, relevant subject matter needs to be achieved by students

Construction Activities in Science

Students might as well reveal creative behaviour through constructing items and objects in the science curriculum Individual or committee endeavours may be emphasized here. Each project constructed needs to show a carefully thought through purpose. Thus, a student perceives reasons for the construction activity. Then the purpose or goal needs to be planned by students with science teacher guidance. Here, a psychological sequence is involved in developing the plans for constructing and making. The learner does the sequencing in a psychological science curriculum when planning to attain the inherent purpose.

After planning, the actual carrying out of the plans is involved. Each ordered sequential step needs to be implemented. Application is involved when the planning is carried out to completion. The final process is to appraise the project utilizing quality standards. Input from the student is needed to appraise the worth or value of what has been constructed

Depending upon the science unit taught, many construction activities can be completed by learners on their present level of readiness. The following, among others, in a unit on "Our Changing Weather" could be appropriate:

1. hygrometers
2. thermometers
3. rainfall gauges
4. barometers
5. wind vanes
6. anemometers

In Closing

There are many learning opportunities in science curriculum which emphasize creativity Among others, the following might well be salient:

1. problem solving experiences.
2. poetry reading and writing
3. prose and its applications in creative endeavours
4. art work as creativity in science
5. creative dramatics and famous biographies of individuals in the world of science
6. construction experiences to achieve objectives of student creativity in science curriculum.

Pertaining to creative writing and utilization of trade books, Gega[3] wrote:

> Here are some ideas for creative writing that you can use repeatedly with different trade books.
>
> Diary Write an entry from an event in the life of George Washington Carver, Marie Curie, and so on ("February 18, 1897 Is it impossible? I have now tried dozens of ways to —")
>
> Letter to a famous scientist from the past or present ("Dear Dr Einstein:")
>
> Interview with a famous person ("What was it like being an astronaut, Mr Glenn?" "It had its ups and downs, Sally," he said with a grin.)
>
> Future autobiography ("An exciting page from your life in the field of _____!")
>
> TV or radio script "You Are There!" (Reenactment and report on the first moon landing, first colony on the moon, development of the first human clone, first successful brain transplant, peaceful visit to earth by creatures from another planet, discovery by junior scientists from room 6 of the languages used by dolphins, chimps, dogs, and so on, and what they have been waiting so long to "tell" us.)

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Questionnaires in Physics, Chemistry and Mathematics devised on the basis of S.O.L.O. Taxonomy for Class X school students in India have been tested and validated. The questionnaires, meant to assess qualitative outcome of learning, have a reliability coefficient of 0.71-0.88 and are Guttman true- types. The student response patterns can be clustered into groups which could be adequately interpreted in terms of S.O.L.O. Taxonomy principle. It is expected that such application of the S.O.L.O. Taxonomy in school subjects will not only enable an objective evaluation of 'how well' a content area has been learned, but may also provide a definite guideline regarding the content and structure of appropriate syllabi construction and way of teaching

Introduction

Theories of learning have undergone a sea change over the years. In the realm of psychology, initial investigations in the field of learning emphasised the quantitative aspect of learning, i.e., how much a student has learned or remembered. However, modern research tends to indicate that within the area of academic learning, a proper evaluation has to take into account the level of understanding achieved by the learner rather than the amount remembered by him. Quantitative evaluation fails to take into account partial understanding or the level of understanding by a student and thus, cannot gauge the depth of a student's understanding of a subject matter. In cases where depth of understanding is sought to be measured through qualitative evaluation, the evaluation criterion is usually a personal criterion of the examiner such as 'elegance' or 'economy' of an answer. Such evaluation varies from examiner to examiner and is essentially subjective in nature.

The Structure of Observed Learning Outcome (S.O.L.O) Taxonomy proposed by Biggs (1982) "is a general framework for systematically assessing quality while at the same time retaining precision and objectivity of measurement." It is a method of classifying learner responses according to the complexity of structure of the elements within the response. This structure should "assume a latent hierarchical and cumulative dimension'' (Collis 1983).

The Taxonomy consists of five hierarchical levels of response structure.

1 Prestructural, where response consists of one irrelevant piece of information.
2. Unistructural, where response is based on only one given piece of relevant information It is consistent but may change from time to time.
3 Multistructural, where response is based on several pieces of relevant information provided in the stem The details are all concrete and consistent in nature, but they are not interrelated and may change from time to time.
4. Relational: The response at this level succeeds in integrating all relevant information provided in the stimulus. However, the details still remain within the concrete realm and within the given context.
5. Extended Abstract: At this level, the response integrates relevant pieces of information within and beyond the stimulus to arrive at a general understanding of the basic underlying principle of the stimulus. Hence there remains a scope for several conclusions.

Tests can be formulated on the basis of the S O.L.O Taxonomy by using the S.O.L.O. technique in reverse and combining it with the idea of 'Superitems' (Cureton 1965).

The objective of this study was to use the S.O.L.O. technique in reverse to design tests in the superitem format in school subject areas at the Secondary School level in India. The subject areas chosen were: Mathematics, Chemistry and Physics. The tests in all the subjects followed the 'Superitem' format where all the questions consisted of four items following each stem. These four items were hierarchically arranged to reflect the Unistructural, Multistructural, Relational, Extended Abstract levels of the S O.L.O. Taxonomy. The questions devised in these subjects had to be such that satisfactory responses would require more and more sophisticated use of the information given in the stem of each superitem (Wearne and Romberg, 1977; Romberg et al, 1982 and Collis, 1983; Collis et al, 1986). The increased levels of sophistication in the responses would parallel the increasing complexity of the structure in the S O L.O. categories. Therefore in each superitem, the correct answering of the first question of each superitem would indicate an ability (of the student) to respond to the problem at the 'Unistructural' level. The correct answering of the second question of each superitem would indicate the attainment of the 'Multistructural' levels and so on.

The construction of a test using the S.O.L.O. Taxonomy consists of two parts:

(i) The construction of the stem
(ii) Construction of the items/questions reflecting the S.O.L.O. levels.

In each of the three school subject areas, it was necessary to construct item stems for problems in different content categories in such a manner, that the area chosen would not be unknown to students and also reflect basic cognitive skills of observation, classification, interpretation and problem solving (Collis and Davey 1984; Collis 1983; Collis and Davey 1986)

Methodology of Test Formulation

A group of ten secondary school teachers was asked to decide on the actual area of the three chosen school subjects on which the tests would be constructed. The area chosen in each of the subjects may be termed as the 'Content Area' of the Tests.

These content areas were:

Mathematics

(i) Numbers and numeration
(ii) Variables and relationships
(iii) Size, shape and position
(iv) Statistics and probability
(v) Measurement

Chemistry.

(i) Structure of the atom
(ii) Chemical bonding
(iii) Reactions and equations
(iv) Solubility and properties of gases.

Physics.

(i) Mass, weight and volume
(ii) Measurement of length and time
(iii) Force and work
(iv) Pressure, upthrust in fluids
(v) Propagation of waves

Content Validation

A group of twenty school teachers was asked to go through the superitems adapted from Romberg et al. (1982) and Collis (1987) to ensure that they were indeed within the syllabii followed in the schools. The same teachers were then asked to judge the superitems in terms of their:

a) selected content area,
b) reasoning levels of comprehension, application and analysis (Wearne and Romberg 1977), and
c) S.O.L.O. categorization of items into 'U', 'M', 'R', 'E'. The object was to find out whether the teacher's categorization on all these three aspects agreed with the intended categorizations. A high level of agreement was found to exist in all the three domains of the three subject areas, which goes to establish the content validity of the tests. Based on the teachers' judgements, the number of superitems/questions in each subject area were finally decided on as:

Mathematics : 9
Chemistry 6
Physics : 6

The superitems thus selected in the three subjects were administered to a group of fifty four class X children of a secondary school, followed by an informal discussion regarding the difficulties the students may have faced in understanding and answering the test questions. Based on this feedback, language problems, problems in the presentation of the items were identified and consequently wordings of a few questions were simplified and some diagrams included to facilitate understanding. The superitems in each subject area were then assembled in the form of booklets in the standard group testing format with student identifying information (name, age, sex etc.) on the first page (Appendices 1, 2, 3). In view of the developmental nature of the tests, the time limit was kept flexible. The tests in their final form were administered to 268 secondary school students in and around Kharagpur.

The scores in different tests of the sample included in this study showed a near normal distribution as shown in Table 1.

TABLE 1

Subject	Mean of scores	sd	Skewness	Kurtosis
Mathematics	15	5.0	0.3	0.272
Chemistry	11	3.7	0.005	0.230
Physics	9	3.3	0.05	0.256

Construct Validation

The construct validation of these tests involves the determination of:

(a) reliability of the tests and

(b) conformation of tests to the Guttman true-type pattern.

To determine the Guttman true-type pattern, the coefficient of reproducibility, and chi-square values — (which are indicative of the goodness of fit of the observed response patterns to the expected ones) were calculated.

Reliability of the Tests

The reliability coefficient (r_{xx}) for each subject was separately calculated using the split half technique of KR 20, as modified by Cureton (1965) for item questionnaire The KR 20 values r_{xx} for all subjects and the values for the correlation of observed and true scores r_{xd} are given in Table 2

TABLE 2

Subject	Reliability coefficient	Correlation of observed and true scores
Mathematics	.71	.84
Chemistry	88	.94
Physics	.80	.89

The reliability coefficients were comparable to those of previous studies in test development using the S.O.L.O. principle. (Collis, 1983; Collis and Davey, 1984 and Collis et al, 1986).

Guttman Scale

Since the structure of the S.O.L.O Taxonomy is a hierarchical one, where the presence of a particular level assumes the presence of all lower levels, the Taxonomy conforms to the Guttman scale (Guttman 1941).

Any pattern of response structure which does not conform to this Guttman true-type pattern i.e., where a student is successful in answering the higher level response without being able to answer the lower (level) one is considered an 'error' The indices used to determine whether student responses conformed to the Guttman true-type pattern were:

(i) Coefficient of reproducibility (r)

$$r = 1 - \frac{\text{total no. of errors}}{\text{total no. of responses}}$$

(ii) Chi-square based on goodness of fit [van den Wollenberg Q test of fit(1982)] between the observed distribution of response types to predicted ones.

In order to be considered a true Guttman type one, an item must have an r value .85 and chi-square not significant at the .05 level (vide Table 3) The results obtained in this study are well above these criteria in cases of both r values and chi-squares The values are also in good agreement with those of similar work previously done in this area (Collis, 1983; Collis and Davey, 1984; 1986)

Clustering of Students in S.O.L.O. Levels

The S.O L.O scores obtained in each school subject area were statistically analysed to determine the nature of responses of student scores and to find out whether the responses clustered at the S.O.L.O level expected for students belonging to this age group. For each of the three school subject areas, student responses were grouped in clusters The average score in each cluster, as well as the percentage of correct responses and the size of each cluster is reported in Table 4. The clusters are also labelled into the four basic S.O.L.O categories, viz , (U, M, R, E) as well as transitional stages between categories. The tendency to approach a category is represented by

TABLE 3

Coefficient of Reproducibility (r) and Chi-square (Q test of fit) in Different Subjects for Confirmation of GUTTMAN Response Patterns

Subject	Item No.	(r)	Chi-square	df	p
Mathematics	1	.98	42	136	> .05
	2	.98	21		
	3	.97	79		
	4	.97	43		
	5	.96	16		
	6	.90	21		
	7	.96	16		
	8	.97	42		
	9	.95	37		
Chemistry	1	.97	21	88	> .05
	2	.96	10		
	3	.98	10		
	4	.96	11		
	5	.98	50		
	6	.98	94		
Physics	1	.98	39	88	> .05
	2	.97	20		
	3	.97	60		
	4	.98	10		
	5	.97	45		
	6	.97	31		

[chi-square values based on goodness of fit test of van den Wollenberg (Masters and Wilson 1988) not significant at $<.05$]

an arrow mark before the category level while the tendency to go beyond a category is represented by an arrow mark after a level, viz., –M denotes the tendency to approach M level and M – denotes the tendency to go beyond the M level.

The number of cluster groups in this study vary from 10 to 8 depending on the subject area concerned. In all subjects, with the exception of Physics, the majority of responses were clustered at the M–M→ categories.

TABLE 4

Percent Correct Responses at each S.O.L.O. Level Clusters in Different Subjects

SUBJECT: CHEMISTRY

S.O.L.O level attained	No. of students	% of correct responses in each S.O.L.O level			
		U	M	R	E
R→	6	100	100	100	3
R	25	100	100	73	0
→R	27	100	100	50	0
M→	31	100	100	33	0
M	93	100	87	17	0
→M	69	100	41	0	0
U	16	75	0	0	0
→U	1	0	0	0	0

SUBJECT· MATHEMATICS

S.O.L.O level attained	No. of students	% of correct responses in each S.O L.O level			
		U	M	R	E
E	2	100	100	100	66
R→	15	100	100	71	22
R	20	100	100	67	0
→R	20	100	83	56	0
M→	76	100	88	33	0
M	78	89	73	12	0
→M	21	89	44	0	0
U→	8	89	22	0	0
U	26	50	6	0	0
→U	2	0	0	0	0

SUBJECT: PHYSICS					
S.O.L.O level attained	No. of students	% of correct responses in each S.O.L.O level			
		U	M	R	E
E	1	100	100	100	50
R→	3	100	100	100	17
R	9	100	100	89	0
→R	21	100	100	59	0
M→	28	100	100	23	0
M	58	100	83	17	0
→M	30	100	50	8	0
U→	98	100	16	0	0
U	17	74	0	0	0
→U	3	16	0	0	0

In Physics, one of the main reasons for the student performance being more in the U-M levels than in other subjects, might have been due to the very nature of the subject as well as the modality of teaching the subject in schools. The subject is more of a conceptual nature. While teaching it in schools also, the emphasis is on the theoretical aspects of the subject with very little practical demonstrations and experiments to help concrete generalization by the student. Students are taught that sound travels through a medium — solid, liquid or gas. In the absence of such a medium between the source of sound and the ear, sound cannot be heard. However, the manner in which information is imparted — as facts — causes an inability on the part of the student to relate this information about sound to the reason why explosion on the sun cannot be heard on the earth.

Such inability to answer openended questions in Physics seems to have arisen from a lack of concretization ability of the known but unobserved facts — and contributed to the low groupings of responses in S.O.L.O. in Physics (between U and →M levels).

According to the 'Developmental Stage Theory' of Piaget, students at 15 years are expected to function at the R-E level. However, as has been pointed out by various authors (Biggs and Collis, 1982 a), the developmental stage of a person determines his upper limit of functioning. Whether the person shall actually function at that level, depends on various other factors like motivation, prior knowledge, etc. Common observation in practical life suggests that in most situations a person functions well below his potential maximum. Hence a student who has potentially reached the 'R' or 'E' level may, in actuality yield responses at the 'M' and 'R' levels. Taking into consideration this practical viewpoint, the fact that there is a large group of students found to be functioning at the M–R levels is not inconsistent with theoretical expectations.

Conclusion

In conclusion, it may be said that the purpose of the analyses related to the questions developed in all the three school subject areas has been satisfied. Their reliability content and construct validity have been established. The items proved to be Guttman true-type ones. From the response patterns of each student in each subject, clusters could be formed that were interpretable in terms of the principle of the S.O.L O. Taxonomy.

It is expected that such application of the S.O L.O. Taxonomy in school subjects will not only enable an objective evaluation of 'how well' a content area has been learned, but may also provide a definite guideline regarding the content and structure of appropriate syllabi construction and way of teaching. Finally, the constant assimilation and synthesization of the concepts within the content area — which constitute the very essence of the S.O.L.O. principle, helps in the development of increasingly complex cognitive processes leading to a deeper approach to learning and understanding.

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□

APPENDIX 1

S.O.L.O Test Items

Chemistry

Instructions

Give your answers on the blank answer sheets, attached to the questions.
Answer all the questions to the best of your ability. Do not leave questions blank /unanswered.

Q.1. Nitrogen and hydrogen react to form hydrazine according to the reaction : $N_2 + H_2 \rightarrow N_2H_4$

The atomic masses of the atoms are: nitrogen — 14 units; hydrogen — 1 unit; oxygen — 16 units.

Answer the following questions:

(a) What is the weight of nitrogen atom?

(b) What is the molecular weight of hydrazine?

(c) Another reaction which occurs between nitrogen and hydrogen is formation of ammonia (NH_3).

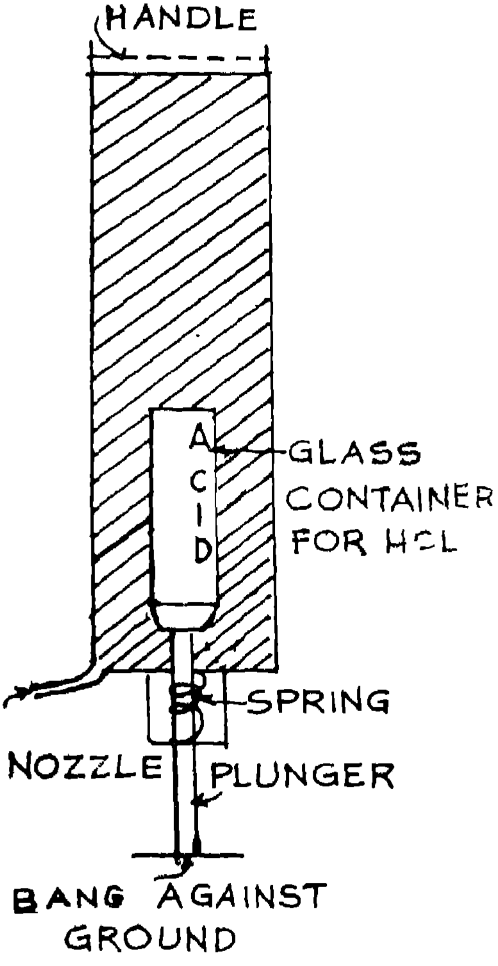

Fig. 1

Write a balanced equation for the reaction.

(d) What are the masses of nitrogen and hydrogen which react to form 68 gm of ammonia; also calculate/determine if there is a change in the total volume of the reactant and the product if the reaction is carried out under constant pressure.

Q.2. There are two main types of fire extinguishers in use today. In one type, the extinguisher cylinder is filled with carbon dioxide gas at very high pressure To put out a fire, the cylinder has to be opened and the nozzle of the cylinder directed to the base of the flame In the other type shown below, the cylinder is actually two vessels, the outer vessel contains dry sodium bicarbonate and the inner contains hydrochloric acid In case of fire the *inverted* cylinder is banged hard against the ground when the plunger on the head breaks the glass vessel releasing the acid which reacts with the soda to form carbon dioxide gas. The gas exerts a high pressure on the liquid and as a result both the gas and the liquid gush out. The nozzle of the inverted cylinder is directed at the base of the fire.

Answer the following questions

(a) What is the name and the chemical composition of the gas which is used to put out fires?

(b) What happens when the gas and the liquid which comes out of the extinguisher is directed to the base of the fire?

(c) Write a balanced equation for the reaction which occurs in the extinguisher drawn above.

(d) Would it be better to put the bicarbonate of soda in the glass vessel and the acid in the container instead of as shown above? Justify your answer

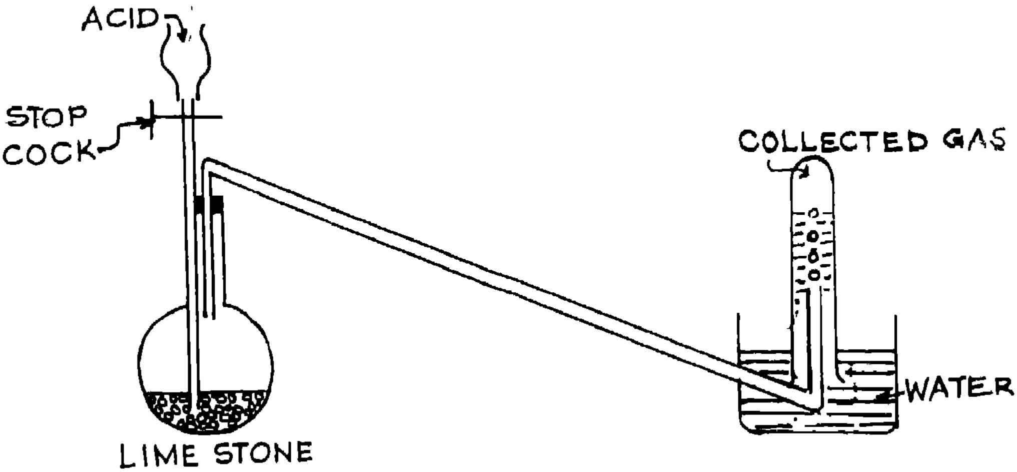

Fig. 2

Q.3. When limestone is placed in a dilute hydrochloric acid solution it reacts with evolution of a tasteless, odourless and colourless gas which is heavier than air. A burning candle placed in the gas is extinguished.

Answer the following questions:

(a) What happens to a burning candle when it is placed in the gas?

(b) The solid used to generate the gas has the chemical formula $CaCO_3$. What is the common name of the solid?

(c) Write down a balanced equation for the formation of the gas and find out the weight of $CaCO_3$ required to generate 1 Avogradro number of the gas. (Atomic weight of Ca = 40, C = 12; O = 16, H = 1, Cl = 35.5)

(d) In an experiment the amount of calcium carbonate which was used was sufficient to generate 100 cc of the gas at NTP; the evolved gas was collected over water as per the diagram of the experimental set-up given here. But it was found that only 40 cc of the gas was collected in the jar. Give two possible reasons as to why a lower volume of gas was collected.

Q.4. The gas law equation states that:

$$PV = kT$$

Answer the following questions

(a) What do the letters in the above equation stand for?

(b) How does the volume vary with temperature if the pressure is kept constant?

(c) Under the same conditions of pressure and temperature what would be the relative densities of hydrogen gas and nitrogen gas?

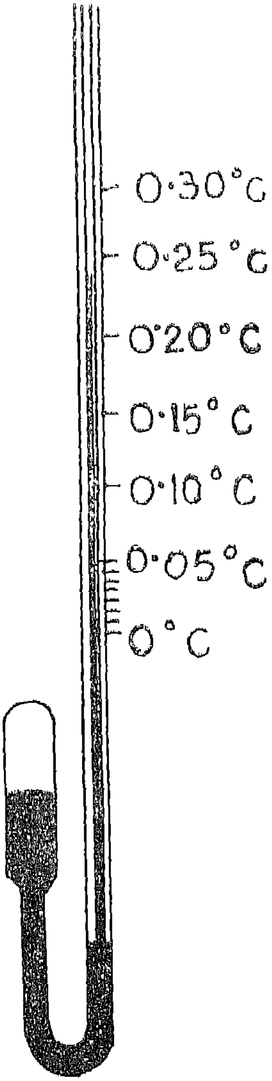

Fig. 3

(d) The maximum sensitivity of the common mercury-in-glass thermometer is not more than 0.05°C. But a gas thermometer of the type shown above can measure changes in temperature as small as 0.005°C. Why is the gas thermometer more sensitive than the common mercury-in-glass thermometer?

Q.5. When solutions of sodium iodine in water and another compound are mixed, iodine is formed. The speed of the reaction depends on the amounts of reactants in solutions. Below is a table which shows the total amount of iodine evolved as a function of time when certain amounts of the two reactants were mixed.

Answer the following questions:

(a) How much iodine is evolved in the first 5 minutes of the reaction?

(b) 6.40 g of iodine is formed in the eighth minutes. How long does it take to form half of that amount of iodine?

(c) What are the rates of formation of iodine during the second, fourth and sixth minute of reaction?

(d) Why does the rate of evolution of iodine decrease with time?

Total time elapsed in minutes	0	1	2	3	4	5	6	7
Amount of total iodine formed (in grams)	0	3.20	4.80	5.60	6.00	6.20	6.30	6.40

Q.6. The model of an ion of charge 2+ is shown alongside

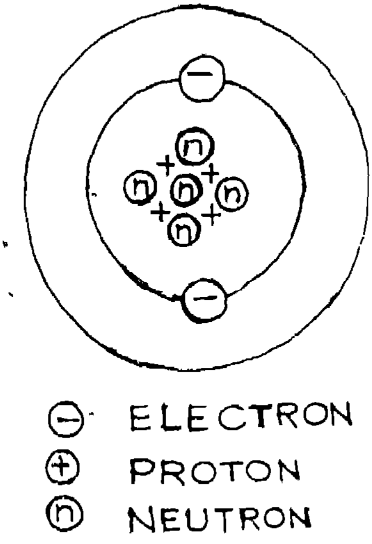

Fig. 4

Answer the following questions

(a) How many neutrons are there in the ion shown above?

(b) How many electrons would the neutral atom of the ion shown above have?

(c) If number of protons in a nucleus is 8, how many electrons would an ion have if it has a charge of 2–?

(d) Is this diagram acceptable as a model of an atom? Give reasons for your answer.

Q.3. When limestone is placed in a dilute hydrochloric acid solution it reacts with evolution of a tasteless, odourless and colourless gas which is heavier than air A burning candle placed in the gas is extinguished

Answer the following questions

(a) What happens to a burning candle when it is placed in the gas?

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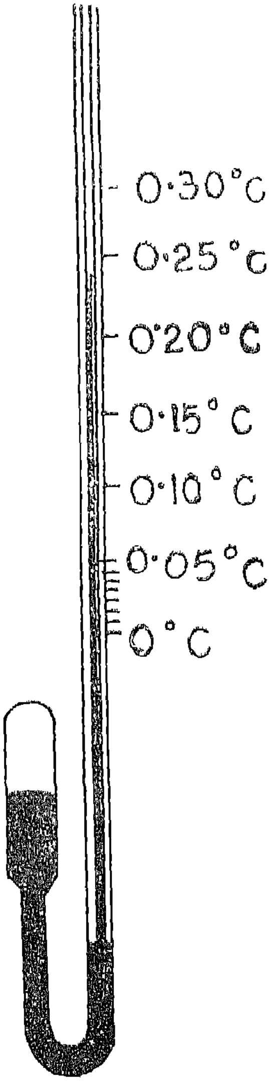

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Answer the following questions

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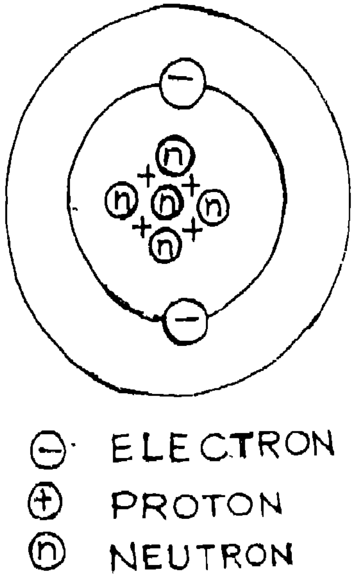

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(c) If number of protons in a nucleus is 8, how many electrons would an ion have if it has a charge of 2–?

(d) Is this diagram acceptable as a model of an atom? Give reasons for your answer

APPENDIX 2

S.O.L.O. Test Items

Physics

Instructions

Give your answers on the blank answer sheets, attached to the questions

Answer all the questions to the best of your ability. Do not leave questions blank/unanswered.

Q.1. Look at the diagram given below and the explanatory statement and then answer the questions.

The lever in the diagram is being used to lift a small load 9 newton.

(a) How far is the fulcrum from the hand?

(b) To just lift the above load the force F is applied by the hand. What is the *downward* force F which just lifts the load?

(c) How much farther from the fulcrum must the hand be if only 2N force can be given by the hand?

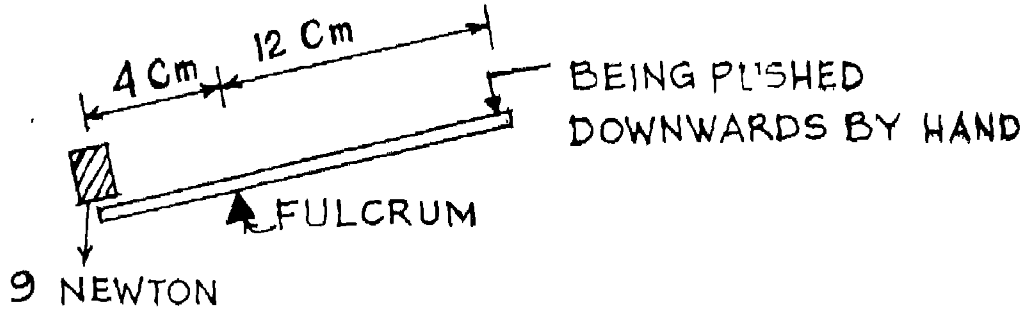
(d) Explain why the work done by the lever to lift the load must always equal the work done in pushing down on the lever.

Q.2. You are given two round balls of the same material. The weight of one of the balls is 200 g and that of the other is 2 kilogram. If they are dropped together from the same height they fall to the ground together at the same instant of time. They fall to the ground due to the attraction of earth's gravitational field.

(a) If both the balls are dropped at the same instant of time from the top of a tall tower will they hit the ground together?

(b) If we had a bird's feather weighing 2 g and a pebble weighing [illegible] g and drop them at the same instant of time from a height of say 10 m from ground level will they hit the ground at the same instant of time? Give reasons for your answer.

(c) The moon revolves around the earth with a certain velocity Why does not the moon



come crashing down on to the earth as meteors do?

(d) Suppose by a technological feat a hole could be drilled from one side of the surface of the earth through its centre and out through the opposite side of the earth. We drop a marble down this hole. Would the marble come out through the other side of the hole or would it keep on oscillating about the centre of the earth as pendulums do or would it do something else? Discuss the motion of the marble as it travels down the hole.

Q.3. A car has a starting speed of V_1 m/s and a final speed of V_2 m/s. It accelerates from V_1 to V_2 in "t" seconds The vehicle's acceleration can be calculated using the formula:

$$A = (V_2 - V_1)/t$$

(a) What does the symbol V_2 stand for?

(b) What is the acceleration if $V_1 = V_2$?

(c) The greatest acceleration of a given vehicle is 8 m/s^2. If the vehicle is travelling at a speed of 6 m/s what is the minimum time necessary for it to reach a speed of 30 m/s?

(d) Given a camera, a clock and a long measuring tape how would you determine the acceleration of a racing car going round in the racing track. You are not allowed in the car or on the racing track itself.

Q.4. The diagram below shows an instrument (hydrometer) used to measure the specific gravity or density of three different liquids. Lower density liquids rise to the top of higher density liquids, unless the liquids are soluble in each other. The three liquids are water, kerosene and dilute sulphuric acid solution in water.

(a) What is the density of kerosene?

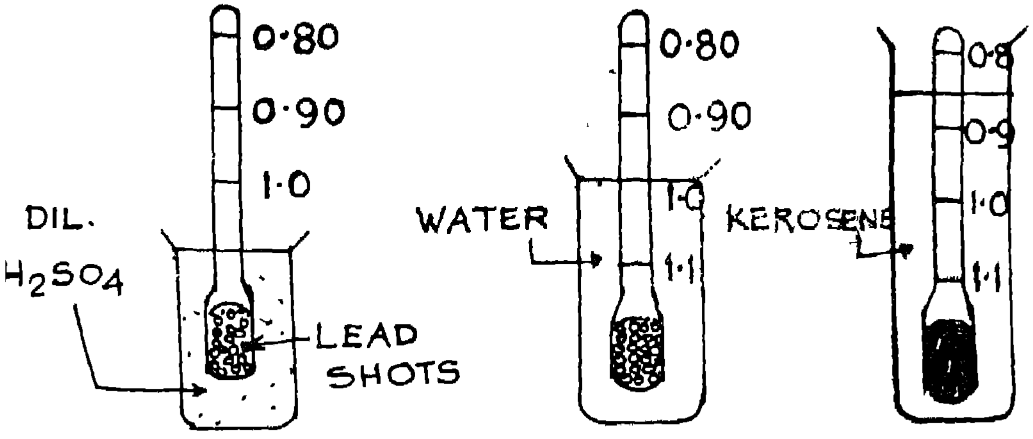


Fig. 6

(b) How much higher is the density of the diluted sulphuric acid than that of water?

(c) The three liquids were poured out into a beaker. Draw a diagram and label the position of each liquid layer.

(d) The weight has been lost from the bottom of a buoy which are used for marking navigable waterways. One suggestion was to fill a bucket with water and attach it to the bottom of the buoy. Would this keep the buoy upright? Explain your answer.

Q.5. Water is one of the few substances which expands when cooled. It cools normally from room temperature to 4°C. On further cooling from 4°C to 0°C, the water expands and at 0°C it changes to ice if cooled further. The graph below shows the relationship between the volume and temperature of 1 g of water.

(a) At what temperature can water and ice coexist?

(b) What is the volume change (in per cent) when 1 g of water is cooled from 70°C to 0°C?

(c) In cold climates water pipes burst if the temperatures fall to below 0°C. Why does this happen?

(d) A graph showing the change of density of water with temperature is given (Fig. 8). Use the information to fill in the temperature of water at different levels of a lake in winter if the temperature of the air has dropped to – 10°C (fill in the temperatures in the diagram given along side the temperature density graph)

Q.6. During thunderstorms we hear the sound of the thunder after we see the lightning strike first.

(a) Why do we see the lightning first and then hear the sound of thunder?

(b) You have a stopwatch with you during a thunderstorm. Can you roughly determine how far away from where you are standing has lightning struck? If yes, how?

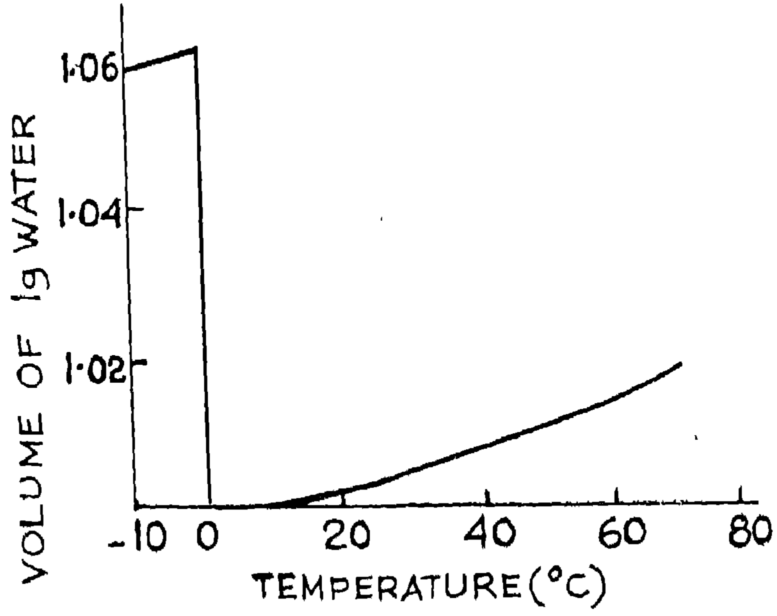


Fig. 7

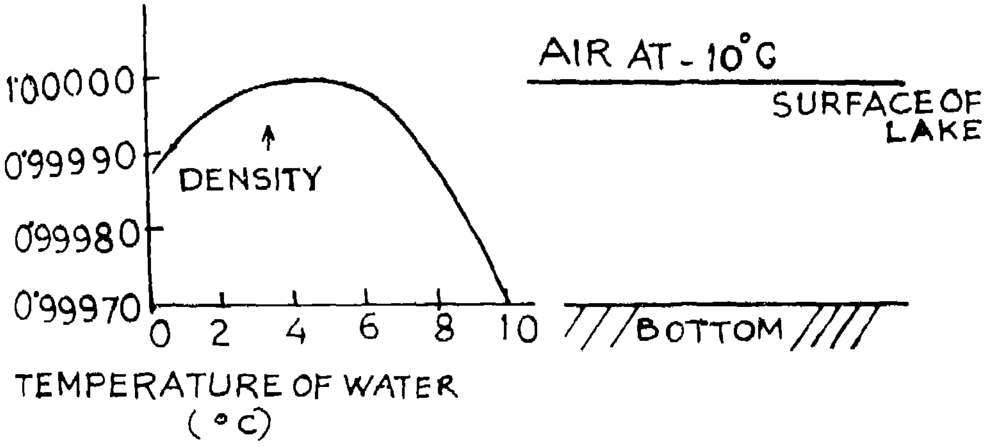


Fig. 8

(c) The sun is a fierce ball of fire where fire storms rage and there are constant eruptions on the sun's surface. Yet we on earth do not hear the sound of these eruptions though we do get the light of the sun all night. Why is it so?

(d) The walls of good cinema halls and auditoriums are always padded with soft things like sponges—why is the practice resorted to? Give reasons for your answer.

☐

APPENDIX 3

S.O.L.O Test Items

Mathematics

Instructions

Answer all the questions to the best of your ability Do not leave questions blank/unanswered.

Problem 1

The example below shows how star (*) marked numbers are added/subtracted:

*2 + *3 = *6; *4 + *5 = *20

*6 – *2 = *4; *9 – *3 = *3

Questions

(a) What is the value of *2 + *3?

Answer__________

(b) What is the value of (*4 + *3) – *2?

Answer__________

(c) What is the value of "*x" in:
*x + *5 = (*12 + *5) – *6

Answer__________

(d) If the following statement is true,
*x – *y = (*10 + *12) – (*15 – *3)

find a general statement for the value of *x

Answer__________

Problem 2

Tom's method of adding fractions was:

$$\frac{1}{8}+\frac{1}{8}=\frac{1}{\tfrac{1}{2}\text{ of }8}=\frac{1}{4}$$

Questions:

(a) Use Tom's method to find the correct number for 'x'

$$\frac{1}{6}+\frac{1}{6}=\frac{1}{\tfrac{1}{2}\text{ of }x}$$

Answer__________

(b) Use Tom's method to find:

$$\left(\frac{1}{4}+\frac{1}{4}\right)+\frac{1}{2}$$

Answer__________

(c) Write down how Tom would do the addition

$$\frac{1}{8}+\frac{1}{8}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}$$

Answer__________

Show that Tom's rule will work for any fraction of the form $(\frac{1}{2})x$, where x is any whole number.

Answer__________

Problem 3

A survey was made of the people going into a football stadium. It was found that most of the people had season tickets and that only 10 out of 100 people had to pay the general admission charge of Rs. 2. There was a meter to count the number of people entering stadium; if the meter read 06392 it meant at that point of time six thousand three hundred and ninety two people had entered the stadium.

Questions:

(a) If 6 people went in after the meter read 06392 what would the meter read thereafter?

Answer__________

(b) The attendance for the first five days of the game in a season was as given in the table:

Game	1	2	3	4	5
Attendance	06021	0358	10211	06102	06940

Arrange the games in order of *increasing* attendance.

Answer — — — —

(c) If the meter read 04400 how much money was collected at the gate on that day?

Answer__________

(d) Due to rising costs the football committee decided that the general admission charge for the following season would be Rs 4 but that the cost of season tickets would remain the same. If 'n' is the attendence at any game, write a general equation for expected difference of money collected at the gate between the two years preceding and succeeding the increase of general admission rates (assume that *n* remained constant)

Answer__________

Problem 4

Companies A, B and C package 3/4 of the total milk production in a state. The fraction packaged by each is shown in the figure:

Questions:

(a) What fraction of milk is packaged by B?

Answer__________

(b) What fraction of milk is packaged by company C?

Answer__________

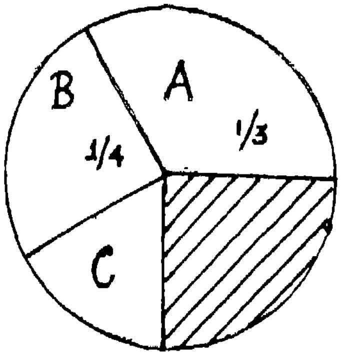


Fig. 9

(c) Company C merged with company B. Which company A or B would be the larger packaging company after the merger and by how much?

Answer____________

(d) If the population of the state grows by x% per year and the percentage decrease of milk consumption per head of population is y% write a formula for the decrease in production of company A at the end of the first year (of the decrease in milk consumption and increase of population) if it yet retains its share of the market and scales down production to cope with the decrease in the total milk demand.

Answer____________

Problem 5

The graph 1 below shows a plot of a car's speed (V) against the driver's reaction distance (r_d); reaction distance is the distance travelled by the car between the time the driver decides to apply the brakes and the time he actually hits it. Graph 2 shows the stopping distance (i.e., the

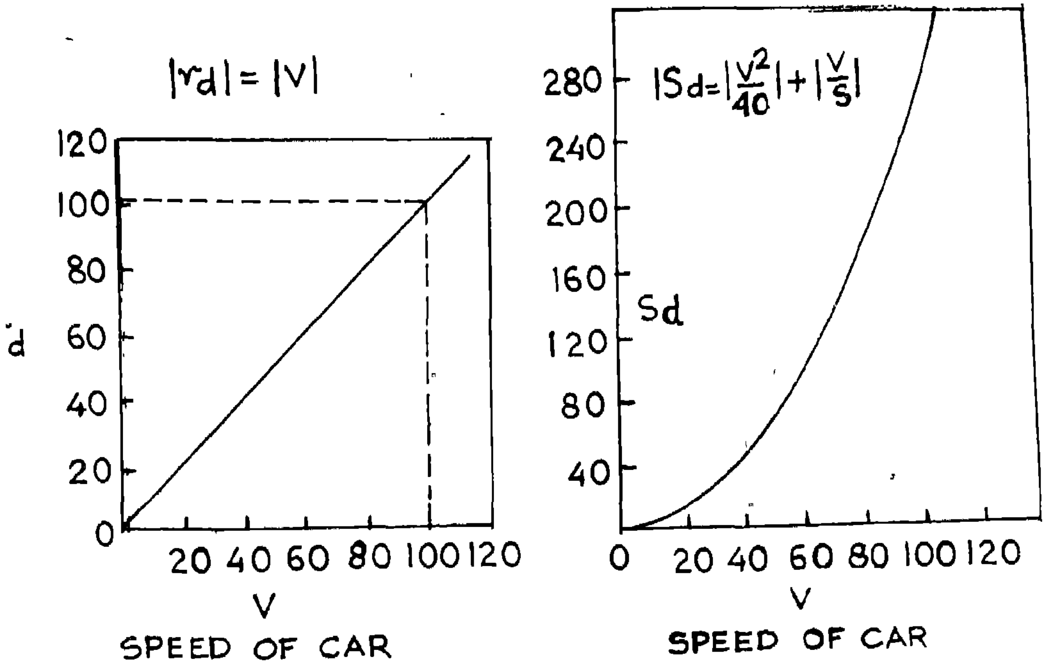


Fig. 10

distance the car travels after application of the brakes S_d) with respect to the speed of the car at the time of application of brakes.

Questions

(a) What is the reaction distance and the stopping distance if the brakes are sought to be applied when the car is travelling at 100km/h?

Answer______ ______

(b) A racing car driver travelling at a speed of 120 km/h saw a STOP sign just 50m ahead would he be able to completely stop the car before he reached the sign?

Answer__________

(c) Devise a formula (for a car travelling at any speed) which could be used to calculate the total stopping distance that the driver needs upon being given a signal to STOP.

Answer__________

Problem 6

A rectangle shown below has been divided into smaller regions A, B, C, D. Two regions are called neighbours if their borders have a line in common. The neighbours of A in the figure are B and C and it is written as: n (A) = BC. For others they are: n(B) = AC n(C) = ABD and n(D) = C

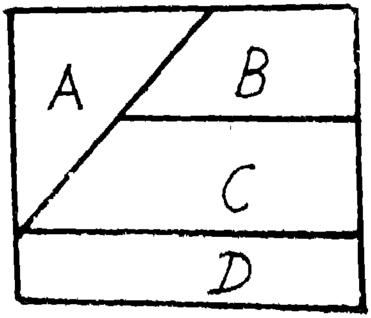


Fig. 11

Questions

(a) From the drawing below determine which is the neighbour of B.

Answer__________

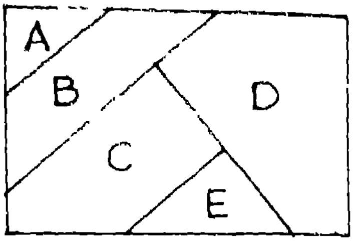


Fig 12

(b) What are the neighbours of 4 in the figure below.

Answer__________

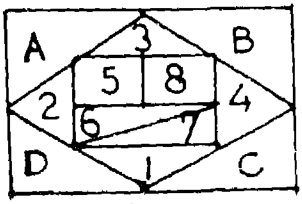


Fig. 13

(c) The table of neighbours of the figure in the next page is:
n(A) = DEF; n(B) = CDE; n(C) = B; n(D) = ABEF; n(E) = ABD; n(F) = AD

Which numbered region in the figure corresponds to F?

Answer__________

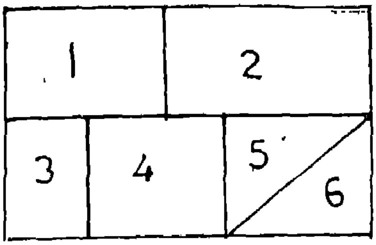


Fig. 14

(d) Information from the table of neighbours in the map given below has been lost. It is known that: (1) E has more neighbours than F. (2) F and G have more than half their neighbours in common. (3) G & E have no neighbours in common.
Which numbered region corresponds to E, F and G in the figure below?

Answer__________

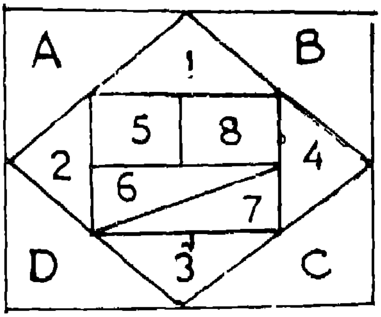


Fig. 15

Problem 7

Tommy was given the following digits 8, 7, 6, 4, 3, 2 and 1 and asked to make any three digit number from these digits, using each digit once only. He said 614 which is correct.

Questions.

(a) What is the smallest 3-digit number that Tommy could make up, using the above digits only once?

Answer__________

(b) Add all the digits Tommy was given and then subtract this number from the largest 3 digit number Tommy could make up from the above numbers using each digit once only. What do you get?

Answer__________

(c) Using the digits he had been given and zero (0), Tommy was asked to write down two pairs of 3-digit numbers so that the sum of the first pair was equal to the difference between the second pair. If he is allowed to use each digit once only in each pair, what two pairs of numbers might Tommy have written down?

Answer__________

(d) How many 3-digit numbers can be made using the original digits Tommy was given if each digit may be used only once in each number and zero is not included.

Answer__________

Problem 8

Johny liked building blocks from small cubes. He made block A by putting 8 cubes together. Then he went to make blocks B and C.

Questions

(a) How many cubes Johny used in making blocks A & B?

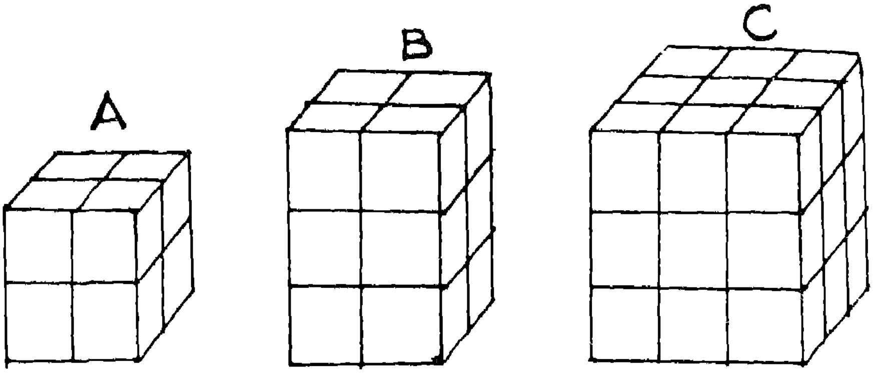


Fig. 16

i) Answer for A__________

ii) Answer for B__________

(b) If the block C was made so that it looked solid from the outside, but actually the outside cubes were stuck together so that it was hollow inside, what is the smallest number of cubes that would thus be needed to create the largest hollow space inside the block C?

Answer___________

(c) A block 8 x 5 x 6 was made to look solid from the outside but the outside cubes were stuck together so that the block was actually hollow inside. How many unit cubes would fit the largest possible hollow space which could be 1st in the hollow block?

Answer___________

Problem 9

The drawing below shows a square; half part of it has been shaded. It may look like either as in A or in B.

Questions:

(a) Shade half the area of rectangle drawn.

Answer___________

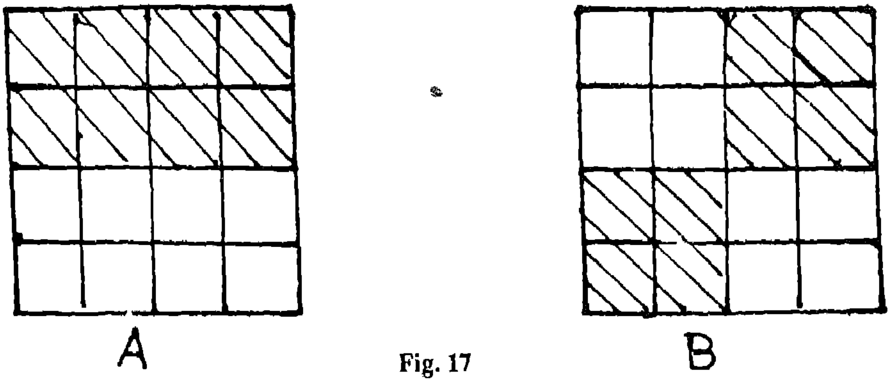


Fig. 17

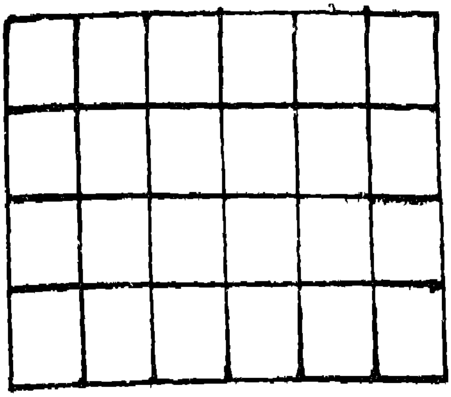


Fig. 18

(b) What fraction of the triangle drawn below is shaded if the areas of the small triangles are the same?

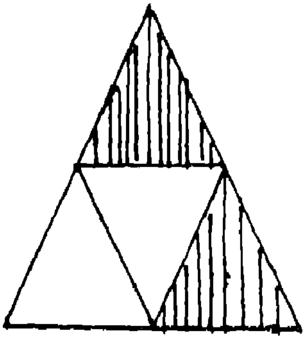


Fig. 19

Answer__________

Answer__________

(c) What fraction of the squares drawn below has been left unshaded? E, F, G, H are the midpoints of the sides.

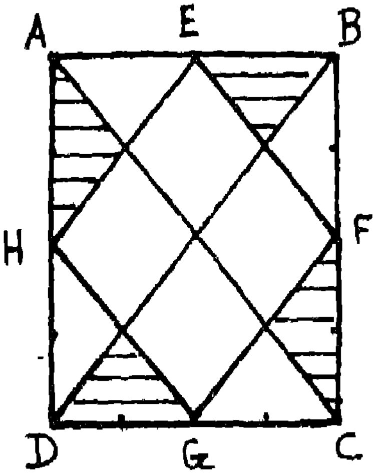


Fig. 20

Answer__________

(d) A certain figure is divided into equal parts and of them p parts are shaded and q parts are unshaded. If $q = k \times p$ write a general statement, in terms of k only for the fraction of the total area that is shaded.

Answer__________

From Awareness to Action via Nonformal Environmental Education

Successful management of the environment, achievement of sustainable, environmentally-sound development, depend upon cooperation among governmental bodies, industry and concerned, informed citizens acting individually, collectively and through their elected officials and governmental agencies. Intelligent and effective citizen participation in environmental cares requires public awareness deepened by knowledge from the sciences, social sciences and humanities. It further requires the development of attitudes and practical skills which aid people to live in a manner which enhances environmental quality and reduces environmental degradation.

One of the most urgent problems today in environmental education (EE) is how to translate and transmit in simple, understandable terms such vital concepts as interdependence, limitation of unrenewable resources, human population growth and energy flow. This becomes of major significance when one recalls a cardinal fact confronting everyone concerned about education: the vast majority of the world's population, youth as well as adult, is outside the formal school system and educational process. Particularly to be targeted are women of the developing world: their role is critical, their contact with the environment most direct, through the family and in the fields, from fuel, consumer attitudes to cultivation of the soil.

In other words, to arrive at an environmentally-informed, intelligent and effective citizenry — the indispensable factor — development of nonformal (out-of-school) environmental education is a must along with formal EE.

The planning, organization and methodology of nonformal EE has varied enormously from one country to another. In Nepal, for example, Radio Nepal has been broadcasting a weekly programme on ecology with an emphasis on the preservation of forests, a particular problem of the country. The Sahel- Vert activity, conducted in Senegal, was a practical exercise in out-of-school EE involving nearly two thousand youth in a tree-planting programme covering almost 700 hectares of the Sahel Desert

Many nations have incorporated special rooms for EE in their nature museums and other educational facilities, in their nature gardens, parks and reserves, etc., (See *Connect*, December 1986, "Micro-Environments for Environmental Education.",

Many programmes are government-inspired and controlled, others are sponsored by non-governmental organizations and some are a combination of both.

Nonformal environmental education may be broadly classified as participatory or nonparticipatory. The latter's target group members are largely "passive receivers" of such media messages as TV–radio programmes, newspaper and other press articles, talks, etc., as well as to a greater or lesser degree, in such activities as visits to nature museums, zoos, aquaria, etc. As for the mass media, their environment role should not be to alarm the public, but rather to alert and educate it with scientifically and pedagogically sound messages. In this connection, two recommendations of an EE meeting of ASEAN countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) are to be cited: (1) "The mass media should be encouraged to *educate* and not merely to disseminate information of environmental concern" (2) "Although the mass media have proved to be an effective instrument for public EE, personal contact, too, must be augmented for the substantive transfer of environmental education, taking into account the culture and educational levels of the target group." (See *Connect* June 1982.) This augmentation of nonparticipatory EE programmes of the mass media with structured, educative and interactive follow-up is most important if they are to be effective.

Class or group discussion is one form of follow-up as well as a general form of education, inside or outside the school. It is obviously more participatory than the usual talk or lecture and therefore a more effective teaching/learning strategy. many adults learns best in a social context and participation in class discussion can develop self-confidence. Ideally, for thorough discussion the number of participants should not exceed fifteen.

The use of radio in developing environmental awareness has been a characteristic of the medium since its origin. In fact, the portable, transistorized radio has arguably become the most widespread and commonly used invention of the 20th century (even as compared, say, to the telephone). However, as mentioned the major problem remains; how to ensure that the environmental message reaches and *activates* its listeners. Many strategies have been devised to achieve this. They include the use of a "forum approach," as in Ghana and Benin, and of a specific instructional way, as in Tanzania and Nigeria. In the latter countries, listeners were organized into groups with the aim of teaching a variety of cognitive skills as well as work skills, which could lead to a heightened quality of life The environmental radio programmes were augmented by written materials and a local teacher or extension worker provided an element of interpersonal communication.

In the "forum approach," emphasis is on group discussion and listeners' views and questions form the basis of much of the programmes. This strategy of using listening/discussion groups also includes the use of written materials and the participation of a teacher, monitor or extension worker to direct activities The use of environmental radio cassettes, wherever existent, is eminently advisable as well, and where not existent, their production in terms of specific local or national environmental problems or issues. Wherever — or whenever — small, portable TV units, complete with environmental video cassettes, are — or will be — widely and locally available, the same strategies are applicable

Among the most participatory forms of nonformal EE is undoubtedly *problem solving*, one of the key aspects of EE (along with *interdisciplinarity*). It provides a basis for relevant and meaningful curricula and helps individuals develop critical thinking skills and a much improved self image. People begin to realize that they can really become agents for change for the benefit of themselves and their society. Admittedly problem solving is a difficult process for both teacher and learner. However, in the process for both teacher and learner. However, in the process learners become encouraged to deal with controversial issues and develop interpersonal communication skills and values which are so important for dealing with complex issues. Similarly teachers and leaders who are not well versed in the art of problem solving become aware of how controversy may spark learning when handled well (See EE Series No. 15, A

Problem-Solving Approach to Environmental Education, which is available to institutions on request to *Connect*; see also this newsletter's June 1983 issue.)

During the last decade there has been an increasing use of popular theatre as part of a two-way communication process in EE. The purpose of such programmes is not simply to impart information in an entertaining way, but also to develop a critical awareness and generate a commitment to collective envrionmental activities. An example of this new approach is illustrated by the Laedza Batanani ("Wake up—let's get together and work together") festivals in Botswana. The festival is a mixture of socio-drama and group discussion and provides a forum for the expression of feelings and an analysis of the major environmental problems faced by the community involved. Each year local community leaders and extension workers meet in a workshop to choose the issues to be examined and accordingly plan the festival.

The methodology and techniques of nonformal education are wide and varied, offering vast opportunities for the spread of EE worldwide. For example *basic literacy for all* has become a project of international priority. A great many countries are now pledged to coping with their own problem of illiteracy by mounting adult, functional literacy projects. Such projects are fertile ground for introducing environmental issues of immediate concern and relevance to the participants. Indeed the result might be and has been — called environmental literacy for all (*Connect* June 1989). For example, consideration of how to improve the quality of life of a village by such amenities as a constant supply of unpolluted water and adequate sanitation facilities, or how to improve the local economy by increased agricultural yields and better marketing, are clearly ideal topics for an adult literacy class. But there is a need to introduce a more penetrating *EE view* to such topics, such as excessive use of pesticides and inorganic fertilizers may give short-term crop yields, *but what of the long-term health and environmental costs*?

As for the EE training of teachers in the nonformal sector, it is essential to identify the needs and requirements of the specific target groups and plan the appropriate training programmes accordingly. For example, any programme concerned with teaching EE to young school drop-outs should illustrate how features of the local environment can be used to develop the basic skills of literacy and numeracy which will, almost certainly, be lacking in the pupils. Similarly, training programmes for those teachers of unemployed young adults should contain a large component of outside project work in which a variety of jobs can be experienced. For adults, methods and materials must be relevant and truly meaningful at *their* nature level; the particular needs and potential of women, where appropriate, should be specially considered.

The desired competencies of EE teachers in general have been previously discussed in these pages (*Connect*, March 1990) as including: (1) foundational competencies in professional education; and (2) competencies in EE content. The latter, in turn, include: ecological foundations, conceptual awareness, investigation and evaluation, and environmental action skills. These competencies apply no less to EE teachers in the nonformal sector of education and their training programmes should similarly include these fundamentals.

(The article above is largely based on a document published in the UNESCO- UNEP Environmental Education Series (No.23). which is titled *Guidelines for the Development of Nonformal Environmental Education*. It is available in English or French to institutions by writing to *Connect*.

Courtesy: *Connect*

Tailor Bird[*]

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If Blue Ribbons were introduced in the feathered world to be awarded to the most skilful nest-builder, then the prize for dexterity would surely go to the tailor bird which is highly interesting little creature in Nature.

Long ago there lived near the palace of Cinderella a little cobbler of the woods, "Tomus Sutorius Sylva." He was dwarf, clad in a pale green suit, with a rusty coloured cap on his head, He was much loved by Cinderella and the Prince, whom she had married, and he often mended shoes for them.

One day Cinderella brought him one of her famous glass slippers, saying,

"Cobbler, Cobbler mend my shoe and get it done by half past two"—and she fled away so quickly, that the cobbler had no time to tell that he could not mend a glass shoe.

When Cinderella came back and found her shoe untouched and unmended, she was very unhappy, because she was afraid she would have to go back to cleaning the kitchen dishes and sweeping the floors, if she was not able to wear her magic shoes.

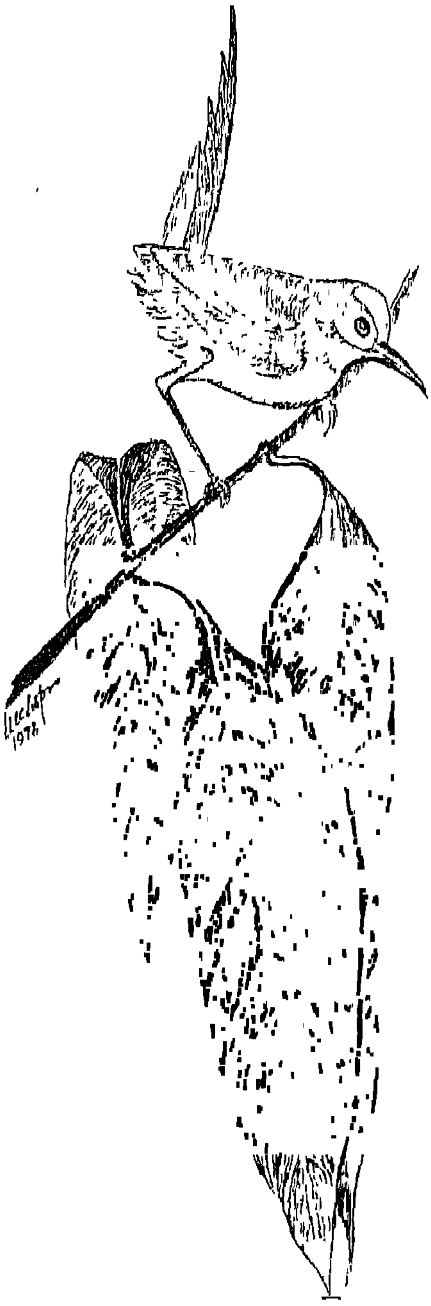

Fig. 1

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[*] Local names, Hindi, Darzi, Bengali, Tuntuni

Her servant was so worried at seeing Cinderella distressed that he hastened to the cobbler and being angry, he nearly killed him, — poor little cobbler. There he lay in agony, almost dead, and the glass slipper smashed to atoms. When Cinderella heard his cries and saw her little cobbler hurt and her shoe broken she wept sorely and begged her Fairy God-mother to come and make everything right.

This was how the cobbler was turned into a Tailor Bird. He did not die after all, but was able to live near the Prince and Cinderella who were so happy, he was alive, that they forgave him for the broken slipper.

Tailor bird's long pointed beak serves him as a needle, so that he is still able to work, but with softer materials than leather. Its beautiful nest is a specimen of his craftsmanship, and his voice, heard so often, near our houses, is an echo of the days when he was a cobbler, singing at his work.

Tailor bird is a familiar small garden bird of the plains which carries its tail — which is long and pointed in summer, short and rounded in winter —erect over the back like a wren.

By name and repute tailor bird is one of the best known birds of India, yet the number of people who can identify it by sight or sound or give any idea of its appearance is very small indeed. Like many famous persons, tailor bird is insignificant in appearance, a small green bird with a pointed tail and rufous crown. It climbs about in undergrowth and is mostly hidden from sight. It is a bird of gardens, of the outskirts of villages, of patches of low evergreen bushes.

Although seldom seen by the unobservant, it is not shy but with endless activity hops about the bushes and creepers, investigating the flowers and willingly feeding within a few feet of people, provided they are not moving about. And as it goes, it constantly utters the loud, discardant, strident call, loud for so small a bird and unmistakable when known, which is a familiar sound in every garden though known to few as the note of this species.

The most ingenious of all birds in nest making, it builds its nest within a cup made by sewing the edges of one or ot two leaves together. It fills this cavity, lined with fine grasses and sometimes animal hair. To sew the leaves together, the bird first pierces holes in the leaf with the point of its beak and draws the thread through, knotting it on the outside enough to prevent its slipping back. Each stitch is made separately. For thread the tailor bird uses plant fibres or silk from insect cocoons or spiders' webs. The nests are usually within six feet of the ground, but may be considerably higher, the main requisite being the presence of leaves to be sewn together.

During the months of May, June and July, tailor birds lay from three to five about half inch long pointed eggs which vary from buffy to greenish and are boldly spotted and splotched. Both the sexes look very much alike, but only the female incubates.

Their diet consists of insects and, occasionally, flower nectar of species like Bombax or Semul flowers and also Katchnar trees.

If Blue Ribbons were introduced in the feathered world to be awarded to the most skilful nest-builder, then the prize for dexterity would surely go to the tailor bird which is highly interesting little creature in Nature.

Science News

Scientists Refute New Planet Theory

Planet "X" the fabled 10th planet of the solar system, is nothing more than myth caused by faulty telecopes and weak research, according to a new study by a Canadian University scientist.

Astronomers have speculated that an unidentified 10th planet called "X" has been shrouded deep in the solar system nestled, somewhere near Neptune and Uranus.

Unexplained movements in Neptune and Uranus have long been linked to the gravitational pull of planet "X" sparking a 126 year old mystery, University of Toronto researchers said.

Computer simulations showed the previously unexplained movements of Neptune and Uranus are part of their natural course. The wobbles mystified earlier scientists who lacked proper tools to chart their orbits.

What the present study has shown is that there was no need for a 10th planet at all, said University of Toronto Professor, Gerry Quilan, who helped the research study.

An Embryo Star

Astronomers using telescope in Hawaii have made the first direct observations of the birth of a star in galaxy. The embryo star is so young that it is still surrounded by a protective cocoon of gas and dust and cannot be seen in ordinary light, according to a London press service report.

The star was first detected in a region around 1100 light years away from the earth in 1983, as a source of infrared radiation, during a survey of the sky by the infrared astronomy satellite.

A team of astronomers from Scotland, Germany and Hawaii found that this radiation source is surrounded by a shell of dust thicker than any yet seen around a young star. This almost certainly means that the source is still forming, with dust from the surrounding shell falling into it under the influence of gravity.

The energy released during the impact of the material landing on the protostar is the source of the object's heat; but the centre of the protostar is not yet hot enough to start nuclear reactions that powerfully grown stars show

The amount of dust around the protostar is the vital clue to its youth implying that it is only a few thousands years old. Astronomers expect another million years to elapse before the star forming process is complete and it becomes visible as a normal star, but one several times more massive than the sun.

The search for the youngest stars in the galaxy has attracted worldwide attention, but until now every candidate object has been found to contain a fully grown star.

The new search focussed on a special region in outer space which has the characteristics of a stellar nursery, including evidence of dust and gases that surround newborn stars.

Animal Behaviour in Space

The tiny jellyfish aboard space shuttle Columbia are acting a little weired in zero gravity, swimming in circles instead of bobbing up and down as they do in the earth's oceans.

But the white rats aboard appear happy and healthy in their space cages.

The seven crew members are sharing space with 2,478 jellyfish and 29 rodents while conducting a variety of experiments designed to learn more about the effects of weightlessness on the body.

"The rodents are very healthy. Sometimes I wake them up to make sure they are bright-eyed and bushy-tailed," astronaut Millie Hughes-Fulford said.

However, TV pictures have shown some of the jellyfish swimming in circles Jellyfish on earth use pulsing movements to travel upward and then sink when the pulsing stops But things do not sink in zero gravity.

"I can definitely say that I see some gross differences", said Dorothy Spangenberg the earth-bound biologist who picked the jellyfish for the trip. "Of course as a scientist, though, I want to study every little animal in great detail, before I will be able to come out with an evaluation of exactly what occurred in space."

The tiny jellyfish have tentacles that pulsate, enabling them to move. Most of the jellyfish are polyps in the first developmental stage of their lives Less than a third were injected with iodine early in the flight to accelerate their growth. The data will be used to develop a space station and other systems.

The astronauts' work included more testing of the neurovestibular system — the brain nerves, eyes and inner ear — which helps the body orient itself against space mothing sickness, a common ailment among astronauts believed to be caused by changes in the system.

Columbia's nine-day medical research mission is scheduled to end on Friday at Edwards Air Force Base, California.

Bright Light for Insomniacs

Scientists have found an effective substitute for sleeping pills — bright lights. All you are to do is to sit in front of strong focussed lights for four hours on two consecutive nights and your morning waking time would be delayed by 90 minutes, scientists of Flinders University in Adelaide have reported.

Dr. Leon Lack of the Psychology Department of the university claims that people who woke up very early slept longer when exposed to bright lights before bedtime. The findings have been published in the Australian Science and Technology Newsletter

Use of bright lights provided as much improvement in sleep duration as the routinely used sleeping tablets. 'This development could well put us onto the road towards achieving a breakthrough in overcoming insomnia (sleeplessness),' Dr Lack claimed. He explained that his subjects were asked to watch a television programme while they were exposed to bright lights emanating from a special box placed below the set. The light altered the 'human biological clock', which regulated the patterns of sleep and waking up. Initial results of his research showed that the benefits of the therapy lasted for a week, but indications were that it could be extended further.

The psychologist said that early morning insomniacs often wished to stay awake until normal bedtime despite their extreme sleepiness in the evenings. However, if they went to sleep at a relatively late hour, say around 11 p.m., they would still wake up within three or four hours and have trouble getting back to sleep. Dr. Lack's research has also shown that up to 10% of people suffered from early morning-waking type of insomnia. Many of them are victims of misalignment of biological rhythms within the 24-hour daily cycle. The biological clocks within them are turned three to four hours earlier than normal. The exposure to bright light in the evenings delayed their rhythms. It helps to synchronize with normal time, enabling them to sleep longer into the morning.

New Strain of Typhoid Germs Surfaces

Medical community in India are worried about the spread of a new class of typhoid germs that are resistant to most conventionally used antibiotics.

Reports of multi drug resistant typhoid causing bacteria, *Salmonella typhi*, have come in from hospitals in Delhi, Bombay, Chandigarh and several centres in South India. Multi-drug resistant *Salmonella typhi* (MDRST) cannot be cured by drugs like chloramphenicol, Cotrimaxazole and Ampicillin, antibiotics that doctors have used for years to combat typhoid;

"This is the first time the MDRST infection has surfaced on a countrywide scale", says Dr. R.A Bhujwala, Additional Professor of Microbiology at the All India Institute of Medical Sciences, New Delhi.

Although drug resistant strains of *Salmonella typhi* have appeared in India over the past few years, the germs usually responded to at least one of the conventional antibiotics. The incidence was also localized and short-term phenomenon. When the current phase of the MDRST infection was first noticed around the monsoon season last year, doctors hoped it would again be a temporary phenomenon.

"But the MDRST infection now is persisting", said Dr. A. Rattan, AIIMS microbiologist "On an average nearly half of all the strains that we are isolating are multi-drug resistant," he said.

For patients, MDRST infection will mean a typhoid fever that will last longer with possibility of complications and recurrence and relatively more expenditure and treatment as doctors are forced to turn to new third generation antibiotics

Researchers have attributed the emergence of MDRST infection to the inadvertent use of antibacterial agents for treating trivial infections like the common cold and ordinary gastroenteritis

Bacteria called *E-coli* which are useful residents of the human gut, if exposed to antibiotics for a long period of time, can acquire resistance to the drugs. This resistance can be subsequently transferred genetically to other bacteria like *Salmonella typhi* which might infect the person.

A paper presented by the AIIMS microbiology team in a paediatrics journal says the increase in the MDRST incidence and its persistence suggested an increase in communicability and survivability of these multi-drug resistant strains.

Professor Meharban Singh, Head of Paediatrics at the AIIMS, says the persisting MDRST infection is making the management of typhoid fever difficult, particularly in children. Although some of the new quinolone drugs are credited with 100 per cent cure rates, doctors say their use in children could have detrimental effects on growth.

Most doctors who reported the incidence of MDRST infection in the journal of paediatrics have called for efforts to discourage the irrational use of antibiotics for trivial infections. One way of avoiding the over-use of antibiotics would be to impose restrictions on their easy availability from drug stores.

New Treatment for Tumours of Spine

A new instrumentation technique for correction of crippling deformities, fractures and tumours of the spine is being introduced to eminent orthopaedic surgeons of India at a workshop organized by the Madras Institute of Orthopaedics and Traumatology.

Called C.D. Instrumentation after Dr. Yves Cotrel and Dr. Jean Dubousset of France, who first introduced it, the technique was first used in India by MIOT some time ago, and has since been employed successfully on 30 patients.

Methods of spinal instrumentation — placing certain implants in the spine to correct deformity — used in the past had adverse side-effects, involved the patient being put in a full body plaster cast and required long periods of bed rest after surgery. In the modern C.D. technique, there are no side-effects, no cast is required and, most significant, the patient can actually walk in a couple of days and resume normal activities in a fortnight, Prof. Norbert Passuti of the University of Nantes, France, who is here to conduct the workshop, told.

He said C D Instrumentation could be called universal instrumentation because of its varied application. The material (steel) used for the rod which is implanted was bio-compatible and caused no problem even after several years. It produced an extremely rigid fixation and, at the same time, being supple, could be contoured so that normal spinal curvature is restored. One or two of the diseased verterbrae could be removed completely. The spine could be stabilized with instrumentation using rods, hooks and screws, and the gap filled with bone graft if needed.

A technique such as C D Instrumentation was vital because neglect or delay in treatment of scoliosis or spinal deformity could shorten the life span because of the pressure on vital organs and cripple normal activity, apart from creating cosmetic problems, Dr. S. Hegde of MIOT said.

The instrumentation varies according to the problem and other factors like the age of the patient.

Asked about the causes of scoliosis, Dr. Hegde, who was trained in France on C D Instrumentation, said it could follow from an attack of polio, spinal injury, infection or neuromuscular disorders.

Medicated Thread to Replace Surgery

A medicated thread prescribed in Ayurveda 2,600 years ago has emerged as an alternative to surgery in the treatment of anal fistula, a painful disease.

The Indian Council of Medical Research said that its four year randomised, controlled clinical trial in four different medical centres in the country has clearly established the efficacy of the ayurvedic thread and its advantage over surgery.

The findings of the trial were published in the latest issue of the *Indian Journal of Medical Research*. According to Dr. S. Satyavati, ICMR Deputy Director General who initiated the trial, new patients are opting for the thread in preference to surgery thereby forcing the ICMR to have the thread produced on a commercial scale by the industry.

Fistula-in-ano, which is common throughout the world, is a disease marked by persistent discharge of faecal matter through a fistulous tract connecting the rectum to the external opening near the anus. The opening is a site of infection and pain. In India, it constitutes 1.6% of all surgical admissions.

The ayurvedic technique known as "kshaarasootra;" eliminates the need for surgery;

it uses a thread medicated with extracts of three different herbs.

The thread is passed through the fistula and brought through the anus where two ends are tied with a knot. The thread is changed at weekly intervals until the fistula heals. The process of healing takes from one to three months depending on the length of the fistula.

The non-surgical method buried in old ayurvedic texts was unknown to the world until it was revived about 15 years ago by the late surgeon, Dr. D.G. Deshpande, of the Benaras Hindu University. During the last 10 years of his life, he applied "kshaarasootra" to treat 2,000 cases of anal fistula, a claim that galvanised the ICMR to launch the multi-centre trials.

In the ICMR trial, 237 patients underwent surgery and 265 received the medicated thread. All patients in both groups were cured, but relapses occurred in 11% of surgical cases against 4% in "kshaarasootra" group.

The ayurvedic treatment, on an average, took eight weeks against four weeks of surgery, but the long-term outcome in terms of recurrence and incontinence is better with "kshaarasootra" than with surgery, the ICMR study said. The biggest advantage, according to ICMR, is that "kshaarasootra" being an outpatient procedure, required no hospitalization.

The efficacy of the technique, having been confirmed, the ICMR is now trying to make the method popular among practising surgeons. "Kshaarasootra" has already made its entry into neighbouring Sri Lanka.

Squint Can be Cured

A large number of people in India suffer from squint or cross-eye which renders them unfit for handling technical jobs. Squint is a condition in which a person is unable to see an object with both the eyes simultaneously It is a blinding disease of one eye that robs the victim of the advantage of two eyes, but the misconception that it cannot be treated needs to be dispelled, says an ophthalmologist, Dr. Prem Prakash.

The situation is rather unfortunate in a country which is in the process of technological development, writes Dr. Prakash in the journal *Hamari Ankhen* (our eyes), a publication of the National Society for Prevention of Blindness.

Unfortunately, squint affects children by and large who are ignorant about the malady and are too young to recognize or complain about their one-eye blindness. He stressed that it is never too early to treat a case of squint He lists certain wrong notions that should be removed, (i) squint cannot be treated; (ii) the child should be allowed to grow out of it; (iii) it should be operated in young adults only; (iv) young children should not be operated or given glasses for the management of squint; (v) it is only a disfigurement, a cosmetic problem, and not a visual defect.

It should be realized that when a child is born, it has poorly developed vision and there is little coordination between the two eyes. Full development takes place with proper visual stimuli by the age of six The two eyes start coordination with each other after birth and fuse the two images into one (binocular single vision) within a few weeks after birth. However, the system of binocular cooperation matures only by the age of 7 to 8 years, says Dr. Prakash.

Any hindrance in the visual development of defect during the development of vision results in a squint. Other causes of squint can include structural developmental damage or defects of muscles, nerves and ligament. Dr. Prakash emphasises that a squint should never be ignored. Infants should be examined periodically at least at birth and later at yearly intervals and treatment should be completed before the child goes to school.

Hybrid Pigeonpea Released

The world's first hybrid pigeonpea plant bred by scientists at the International Crops Research Institute for the Semi-Arid Trophics (ICRISAT), near Hyderabad, has been released for use by farmers in central India.

This technological break-through at ICRISAT is significant because for the first time in the world, a hybrid of a pulse crop has been developed. This is difficult because flowers of pulses have a structure designed for self-pollination, said an ICRISAT press release.

Pigeonpea, known also as *tur* or *arhar* is a pulse crop that forms a major component in diet of the Indian subcontinent and is important source of protein.

The technology developed at ICRISAT throws open new opportunities to agricultural scientists working on the crop and for seed companies to provide hybrids that yield more than the varieties cultivated presently by farmers.

The ICPH-8 variety is quick to mature, escapes common diseases and yields 30 to 40 per cent more than the popular open-pollinated varieties. It performs well under drought as well as high-moisture conditions. In pre-release trials, this hydrid has performed very well in Maharashtra and Gujarat. Indications of its performance in Uttar Pradesh, Madhya Pradesh, Karnataka, Haryana, Andhra Pradesh, and Tamil Nadu are encouraging.

To facilitate the supply of the high-yield pigeonpea hybrid seed to farmers, ICRISAT scientists evolved the seed production technology to benefit the seed companies. Large-scale hybrid seed production is fairly easy and does not cost much.

Book Reviews

A Level Physics

by Roger Muncaster
Published by Stanley Thornes
(Publishers) Ltd.
Old Station Drive
Cheltenham GL 53 ODN
Indian Edition: The Student's Stores
Delhi, pp. 872

The book under review claims to have incorporated all the basic requirements of the common core of A-level Physics courses in Britain. As such this textbook cannot be prescribed in Indian schools as there are no A-level or 0-level courses. However most of the content given in the book covers almost the entire syllabi of Physics for senior secondary prescribed by the CBSE and other State Boards of Education.

At first glance, it appears that the format adopted for the presentation of the content is traditional one, that is, compartmentalizing the content under areas like mechanics, heat and geometrical optics, etc., but a closer look reveals that it has been arranged in an entirely different way which is very systematic and coherent. The whole syllabus has been divided into large number of areas and each area has been dealt with in one chapter. The subject matter of each chapter has then been very consistency developed in various sub-units A direct and concise approach has been adopted by the author to introduce every topic which makes subject matter easy to comprehend. In each chapter, starting from very basics the author has gradually built up the subject matter from lower to higher cognitive level maintaining the continuity of ideas and concepts from beginning to the end. Various aspects of the content ranging from definition to derivation of formula involved have been fully covered.

To facilitate the explanation and understanding of concepts, labelled diagrams, graphs and tables have been provided at appropriate places in adequate numbers. Enough problems and exercises have been provided for each topic. The concepts have been further reinforced, wherever desirable with the help of solved numerical examples at the end of each sub-unit Sufficient number of numerical problems have also been provided at the end of each chapter so that students may get an opportunity to further strengthen their understanding of the underlying concepts. This section may be especially useful for those who wish to prepare themselves for various entrance examinations after senior secondary examination.Answer to all numerical problems have been provided at the end.

A set of appendices has been provided at the end which includes a discussion on Basic Ideas Relating to SI Units, Dimensions and Dimensional Mathematics, Relevant Mathematics, and values of selected physics constants. At the end an index has been given which is not commonly found in the text-books published in India for this level. However, there are some basic differences between a physics textbook for senior secondary classes prescribed by CBSE and the book under review. Whereas in the former the content are arranged more or less in the same sequence as the syllabus with clear demarcation for the contents for classes XI and XII, the same is not true for the latter.

The book under review therefore may be most suitable as a reference book for those appearing for senior secondary examination as well as for those who are preparing for various entrance examinations.

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Gender and Mathematics — An International Perspective. Edited by Leone Burton, 1991 Cassell Education Limited, Villiess House, 41/47 Stranel WC 2N 5JE, Pages 161.

This book is a collection of 14 papers, from the work of the International Organisation of Women and Mathematics Education with an introduction by L. Burton. The papers are divided into four sections—Gender and Classroom Practice, Gender and Curriculum, Gender and Achievement and Women's Presence in Mathematics—insight into the complexity of the issues involved in gender bias and how to overcome it to ensure women's equal participation and achievement in learning of mathematics. The book presents qualitative and quantitative methods for a variety of perspectives on issues related to Gender and Mathematics and is recommended for reading to mathematics educators/teachers/administrators/curriculum planners/researchers in mathematics education and those interested in Women Studies.

Five papers in the section Gender and Classroom Practice deal with the classroom and teacher environment within which mathematics education is imparted and its effect on the learners, especially females. In a study of classroom practices in Australia, G. Leder, presents consistent differences in teachers' behaviour towards boys and girls which reinforces differences in their perceptions of themselves as learners of mathematics which ultimately gets translated into differences in achievement and participation in mathematics.

Z. Issacson draws following infrences from experiences of women who come to study mathematics at a later stage (i) teacher plays the central role in encouraging girls to specialize in mathematics for a more rewarding career (ii) independent, original creative thinking and imagination should be valued in mathematics classroom (iii) emphasis should be placed on discussion in a collaborative, cooperative and non-competitive environment. M. Rogess analysed the rationale of school students including those attending out of school leisure mathematics classes to continue higher study in mathematics. She concludes that the learning situation must contain a fine balance of sufficient challenge and sufficient experience of success. Too much or too little of either can produce anxiety and mental paralysis of boredom and apathy. Humour, laughter and play should be used to facilitate learning. Pat Rogers concludes that the secret of success of the Potsdam Mathematics Department of USA lies in attracting high percentage of women and a style of teaching which instils self-confidence and a sense of achievement in all pupils by involving enquiry, discussion and collaborative work. The focus is not on the transmission of knowledge but on developing mathematical thinking and reconstructing ideas through independent learning.

In a study of personal and intellectual attributes of eight university Professors of mathematics and four of Social Science, L. Taylor found the female mathematicians to be "as confident mathematically and equally uncomfortable in social situations as men". This, as L. Burton points out, may be due to "a process of acculturization which remains unchallenged in the majority of classrooms and curricula offered to learners of mathematics"

The three papers in the section, Gender and Curriculum, deal with the content of the curriculum and the pedagogical style of its presentation. H. Verhage emphasizes in her paper the importance of content of presentation from women's traditional as well as emancipatory domains which are appealing to girls so that they can identify with the subject matter and are motivated to take mathematics related career. She concludes that mathematics should be presented as dynamic, creative, relative and personal since it appeals to women. M. Barnes and M. Coupland, and B. Marr and S. Helne present case studies based on their own teaching experiences which infer that the content and the method should be relevant to and take into account the experiences, the needs and the interests of women. They advocate student-centred enquiry method in which students enjoy mathematics and experience success.

The third section, Gender and Achievement, deals with gender distribution and achievement in mathematics. G. Hanna, et al conclude from the analysis of data of 2nd International Mathematics Study of fifteen countries that between country gender differences are often greater than within country differences, and that any sex differences that do exist are not consistent across all countries. Biology is definitely not the basis of greater differences. The complex factors accounting for the differences should be explored from different perspectives. B. Kaur compares achievements of girls and boys in Singapore at 16+ in a particular mathematics syllabus. Boys outperform girls in general and in particular in quantitative and spatial visualization. This may be attributed to comparatively greater time spent by boys than girls in outdoor activities which nurture spatial visualization skills. E. Tressou Milonas studies children's attitudes to and progress in mathematics in three primary schools in Greece under individual learning scheme. In both performance and attitudes, the girls were equal to or superior to boys. Social class was more noticeable discriminator between pupils than was gender.

The three papers in the fourth section deal with Women's Presence in Mathematics. J. Becker concludes from her study of graduate students of Computer Sciences at two universities that a problem-solving methodology is attractive to those who are successful in Mathematics and Computer Science. This is in accordance with the present emphasis in School Mathematics on applicable, enquiry based investigational approach. P. Purser and H. Wily report a decrease in number of all mathematics graduates, especially women in New Zealand. This would entail less well-trained female teachers of mathematics in schools which removes role models for girls. G.Fenaroli et al present a historical review of Italian research papers by or about women mathematicians over the period 1887-1947. They also note that although the number of women in mathematics is increasing yet the top positions occupied by them are comparatively small in number.

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A QUARTERLY JOURNAL
OF SCIENCE EDUCATION

SCHOOL SCIENCE

Vol. XXVIII No. 4
December 1990

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TO OUR CONTRIBUTORS

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Philosophy, Computers and Mathematics

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The mathematics teacher needs to study and analyze diverse schools of thought in the software/computer curriculum Each philosophy has selected recommendations to make in teaching-learning situations The philosophy emphasized needs to harmonize with the personal learning style of a student.

The mathematics curriculum needs to place heavy emphasis upon computer utilization. Software packages need to guide learners to achieve objectives. Each software package should stress sequential subject matter to be acquired so that more optimal student progress in mathematics is possible With quality sequence, learners should experience increased success when interacting with the content presented on the monitor Sequential learning emphasizes a relationship of new subject matter attained with that previously acquired. Knowledge that is related should be retained longer by students as compared to that which is fragmented. Quality software in mathematics should provide content which is correlated, fused and integrated with subject matter previously achieved

Software content needs to capture student interest Thus the student and the mathematics curriculum become one, not separate entities. Subject matter then presented on the monitor attracts learner attention. Set establishment is in evidence. An inward desire exists by the student in wanting to achieve relevant objectives in mathematics.

Purpose needs to be in evidence to achieve vital facts, concepts, and generalizations in mathematics. The mathematics teachers may stimulate students, inductively or deductively, to accept reasons for learning. After purpose has been established, students need to be actively involved in achieving vital subject matter from the ongoing software presentation.

Thus success in learning, student interest, as well as learner purpose in software/computer experience are a must in a quality mathematics curriculum.

Philosophy of Education in Mathematics Software Utilization

The mathematics teacher needs to study and analyze diverse schools of thought in the software/computer curriculum. Each philosophy has selected recommendations to make in teaching-learning situations The philosophy emphasized needs to harmonize with the personal learning style of a student.

First of all a problem-solving strategy may be implemented in ongoing lessons and units Flexible steps of problem-solving include careful identification of a problem in mathematics. The problem should be selected by students with teacher guidance in a contextual situation. Each problem is life-like and comes from the societal arena. Thus the mathematics curriculum is not separated from society.

Information needs to be gathered in answer to the problem. Subject matter contained in relevant software might well be a part of the total needed information. Other reference sources may also be utilized such as mathematics textbooks, workbooks and audio-visual materials. A hypothesis results which is an answer to the problem. The hypothesis is tentative and subject to modification as a result of testing. A hypothesis is not absolute, but tentative in nature. Salient software then has an important role to fulfill in the total problem-solving sequence and arena.

Problem-solving strategies in mathematics do not

1. have predetermined objectives for student attainment
2. possess a logical sequence in which the mathematics teacher/educator selected sequential learning activities for students.
3. emphasize a behavioural model of teaching. Behaviourism stresses objective, measurable results in each step of student learning.
4. advocate paper-pencil tests to secure data on student achievement. Rather, the ability to define and solve real problems in mathematics provides evidence of learner achievement.
5. stress a highly structured sequence in the curriculum. Problem-solving emphasizes openness, creativity, and flexibility in problem identification, information gathering, hypothesizing, as well as testing and revising the hypothesis.

Information acquired and hypotheses testing might well provide for utilization of quality software

Pertaining to problem-solving, Grossnickle, Reckzeh, Perry, and Ganoe[1] wrote the following:

> Problem-solving is a process by which the choice of an appropriate strategy enables a pupil to proceed from what is given in a problem to its solution. Often the answer is the least important part of the problem-solving process; few of the answers children obtain in school mathematics will have much value in their lives. The ideas used in the process are much more valuable than the answer Thus, it is important for teachers to determine whether an incorrect answer is due to an error in process or in computation. Do not, however, infer from this discussion that errors in computation are acceptable; rather, keep in mind that overemphasis on answers may impede the pupil's understanding of the process. A pupil with poor computational ability who understands the process can use a calculator to get the answer. A pupil who can compute rapidly and accurately but does not understand the process is lost.

A second philosophical school of thought in microcomputer/software use in mathematics is a decision-making strategy With decision-making, the student selects learning activities from among alternatives. Thus in mathematics, an adequate number of software packages are available from which learners may select to pursue. A brief description of each is available to the learner. The student is the chooser and omits those not possessing purpose, meaning, and interest. In addition to software programmes, other avenues in learning are available such as textbook/workbook activities, as well as audio-visual experiences.

A learning centres approach may be utilized. Each centre contains relevant software related directly to the mathematics unit presently being taught. Content on the monitor for student interaction and acquisition of subject matter guides the learner to attain vital objectives. Diverse routes, including salient software, may be selected by the learner to attain objectives. To make choices means to choose from numerous software packages in order that objectives may be achieved. A psychological mathematics curriculum is in evidence if each student sequences his/her routes (learning opportunities) to attain salient objectives. To emphasize increased decision-making, objectives to achieve may be chosen by the learner A major goal here is that the student will select those objectives that are most challenging. Optimal achievement for student attainment is of utmost importance in decision-making. Time on task in selecting and interacting with software content is a must. Through self selection, the student becomes actively involved in making choices in the mathematics curriculum. The learner is an active being rather than a passive recipient.

A contract system might also emphasize a decision-making strategy. Here the student with teacher guidance determines which computer programmes to complete. These are written up in contract form with the due date specified. Both the student and the teacher sign the agreed upon contract for learning activities to be completed by the former. The student then selects sequential programmes to complete.

To further stress decision-making strategies, students with teacher assistance may plan selected objectives of instruction in mathematics. To achieve the chosen objectives, students and the teacher cooperatively determine the learning opportunities, computer/software as well as other activities. Appraisal procedures should also be cooperatively developed.

Decision-making strategies do not emphasize:

1. a predetermined mathematics curriculum. Rather heavy input from learners is involved in selecting objectives, learning opportunities, and appraisal procedures within the framework of the mathematics software/computer curriculum.
2. a subject centered curriculum only. Attitudes and the affective dimensions are equally salient to emphasize as objectives of instruction in the mathematics curriculum involving computer/software utilization.
3. an essentialist or basics curriculum for all students. Rather choices and decisions, from among alternatives, may be made by learners in terms of activities and experiences in software programmes to pursue
4. a logical curriculum whereby the mathematics teacher or state-mandated objectives determine sequentially what students are to learn. Rather the learner in a psychological curriculum determines sequentially that which is to be learned
5. a formal mathematics curriculum. Instead flexibility and open-endedness are two viable concepts in that the student makes choices and decisions in the computer/software mathematics curriculum.

Abelson[2] wrote the following on student control over computers/software:

> Logo is the name for a philosophy of education and for a continually evolving family of computer languages that aid its realization Its learning environments articulate the principle that giving people personal control over powerful computational resources can enable them to establish intimate contact with profound ideas from science, from mathematics, and from the art of intellectual model building. Its computer languages are designed to transform computers into flexible tools to aid in learning, in playing, and in exploring.
>
> ... We try to make it possible for even young children to control the computer in self-directed ways, even at their very first exposure to Logo. At the same time, we believe Logo should be a general purpose programming system of considerable power and wealth of

expression .. More than 10 years of experience at MIT and elsewhere have demonstrated that people across the whole range of "mathematical aptitude" enjoy using Logo to create original and sophisticated programmes. Logo has been successfully and productively used by preschool, elementary, junior high, senior high, and college students, and by their instructors.

A third philosophy of instruction to emphasize is measurement driven instruction (MDI). Measurement driven instruction stresses the utilization or predetermined objectives for student attainment. The objectives are stated in measurable terms prior to microcomputer/software use. Each end is precise. Either a student has/has not achieved the specific objective(s) after instruction. The objectives may be state-mandated, district wide instructional management systems, or written by the mathematics teacher.

To attain each objective, the student needs to experience quality software programmes. Each programme needs to align directly with the measurably stated objective(s). Subject matter contained in the software package then guides students to achieve the measurably stated objective(s) Content experienced by students must be sequential so that optimal learner progress is possible

Appraisal procedures must also align with the objectives so that content validity is in evidence. Reliability in measurement procedures is a must, be it test-retest, split-half, or alternate forms

A carefully structured sequence of objectives, learning opportunities involving computer/software use, and appraisal procedures needs to be in evidence. Each component—objectives, learning opportunities, as well as appraisal procedures—is related to the other component. Thus, designing the curriculum with a measurement driven instruction model might guide students to achieve more optimally in the computer/software mathematics curriculum

Measurement driven instruction does not emphasize

1. an open-ended mathematics curriculum whereby input from learners is in evidence pertaining to selecting software programmes.
2. a psychological sequence in which students are involved in sequencing their own experiences. Rather, mathematics educators select objectives, activities, and appraisal procedures in the hardware/software curriculum.
3. decision-making by students as to scope and sequence of the mathematics curriculum.
4. problem-solving activities which relate society and school mathematics within the computer/software curriculum.
5. general objectives in mathematics. Instead, precise, measurably stated ends are emphasized in ongoing activities.

In Closing

Software programmes in mathematics might emphasize

1. problem-solving strategies. Real life problems in mathematics need identification and solutions.
2. students selecting from among alternative objectives and learning activities, as well as appraisal procedures.
3. measurement driven instruction. With precise predetermined objectives, students either do or do not achieve measurable ends as a result of learning activities.

The writer recommends continued emphasis be placed upon problem-solving. In the real world of society, individuals select and solve problems. Personal and social problems need solutions.

Software programmes in mathematics may emphasize:

1. drill and practice to have students review what has been learned previously.
2. tutorial to guide students to acquire new content in sequence.
3. simulations whereby students experience problem-solving in a role play situation.
4. games in which students individually or in a small committee compete against others in an atmosphere of respect and appreciation.

These four kinds of software packages should guide each student to achieve as optimally as possible in the mathematics curriculum.

Computer literacy in mathematics is important for all students. Pertaining to computer literacy, Flake, McClintock, and Turner[3] wrote·

Of all the uses of computers, which ones should all students learn to do comfortably and successfully? These questions have stimulated controversy among educators. Some people equate computer literacy with the ability to select and use commercial software. Their argument is that the average person does not need to know how a computer works, what RAM is, or how to write a computer programme. They compare using a computer to driving a car—in order to drive, one does not need to know how a car works, what a manifold is, or how to do a tune-up.

On the other hand, some people equate computer literacy with knowledge of programming Their argument is that in order for a person to use the computer to solve problems, that person needs to have the flexibility and control that a knowledge of programming provides. In short, knowledge is power.

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Improvement of Science Education in Schools: Indian Context

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It has now been recommended that while teaching science, technology must find a place in every child's experience Link of science with the society is required for better learning and at the same time to develop understanding about the problems of the society The teaching-learning situations need to be selected from the environment of the pupil and worldwide concern about environment demands that science education must be linked with it.

Introduction

Whenever we talk about "improvement", we mean to bring about some desired changes in the existing condition towards its betterment. If improvement of science education in our schools is our goal, then we must be fully aware of the existing conditions vis-a-vis science education in schools of our country. Once these prevailing conditions are clearly understood, only then would it be possible to think about remedial measures. And to visualise the remedial measures, we must know the contemporary focus of science education. Finally on the basis of our past experience, we must also find the ways and means to make the remedial measures effective.

Existing Status of Science Education as a Discipline

Science education as it is known today evolved along with education as a process. Application of findings of experimental psychology to education started from the early 19th century and continued up to the middle of 20th century. In the post world war II period, sociological ideas and methods joined the education. This enhanced the researches in education, which centred round three principal areas: 1) Social context of the educational institutions and students, 2) Nature of the teaching process and 3) Child's growth, specially intellectual development.

The findings of these research studies led to the coming of a number of textbooks on curriculum development and four "essentials" were identified for designing a curriculum (Tyler, 1950).

1 Determination of educational objectives representing the kind of behaviour that is to be developed in the student.
2. Decisions about the kind of learning experiences which might be relevant to the objectives, e.g. skills in thinking, acquiring knowledge, developing social attitudes and interest.

3. Organisation of experiences to provide continuity, sequence and integration within some general pattern.
4. Working out means of evaluation to assess the extent to which the objective had been achieved.

In the early part of the 50s, development of science curriculum started as structured curriculum. On the basis of a theme, contemporary information was logically and sequentially presented as components. It was thought that this would help the child to construct a whole structure. Attempts were made to bring the school subject close to the higher level academic discipline and efforts were made to help the pupil to learn science like the scientists.

This trend of science education gained momentum in the 60s, i.e., shortly after the launching of Sputnik. It began in the USA and gradually spread all over the world. Four reasons were responsible for the expansion of this trend:

1. Rise of educational expectations of students and their parents.
2. Coming of newer methods of teaching.
3. Coming of knowledge explosion, together with population explosion.
4. Occurrence of changes everywhere in the environment at a faster rate.

Several new features were seen in this curriculum development:

1. Subject experts, education experts, educational administrators and teachers joined together in the task of curriculum development.
2. Curriculum included a total package.
3. Curriculum development was supported by State or private funds.
4. There was a search of relevance—relationship with contemporary life and current state of knowledge.
5. The emphasis was on enquiry and discovery.
6. The emphasis was on the self-activity of the pupil.
7. Current innovations of teaching techniques specially teaching aids were used.

A change in the approach from teacher-oriented to child-centred curriculum was noted in the seventies. From the "product" of science, concentration was placed on the "process" of science. The emphasis on the discovery-learning by pupils on their respective programme brought flexibility in school education. Instead of preparing the child for the present, attempts were shifted to the future, i.e., to a society that did not yet exist (Faure, 1972).

But soon it was felt that a balance of "product" and "process" is required. Even in a child-centred curriculum, the teacher has to play the most important role. For this reason, from 80s, the focus was placed on strengthening of teacher education, so that the teacher not only becomes expert in transaction but also can develop and evaluate his/her own curriculum.

While coming close to the beginning of the 90s, it was found that no country was satisfied with its own school science curriculum. It was felt that too much emphasis on "process" diluted the knowledge of the "product". Rigour of science needs to be kept in mind to keep close to the advanced nature of science.

It has now been recommended that while teaching science, technology must find a place in every child's experience. Link of science with the society is required for better learning and at the same time to develop understanding about the problems of the society. The teaching-learning situations need to be selected from the environment of the pupil and worldwide concern about environment demands that science education must be linked with it.

The Present State of Science Education in Indian Schools

No consolidated account on this is available, but we have a plethora of data collected through personal experience, findings of educational surveys and isolated reports. Let us try to list* them:

1. According to the Fifth All India Educational Survey (1986), in the first ten years of school, 12,47,05,810 students are studying science as a compulsory subject and nearly 34,18,925 teachers are teaching them in 7,20,306 schools.
   The discipline-wise higher secondary curriculum is taken up by nearly 43,100 students in 10,775 schools. At least one M.Sc. teacher is there in each school for each subject (What would be the picture in 2000 A.D.?).
2. Science has been introduced from the lowest level in all the States and UTs and it continues as a compulsory subject up to Class X (Is there any exception?).
3. Nationalised textbooks are followed up to Class V in all the States and UTs. From Class VI and above, several States continue to use textbooks developed by private publishers. (Is it true? Do we have a Statewise information?).
4. Up to the lower primary level (Class V) the syllabus is prepared by the Educational Directorates. Boards of Secondary Education do it for Classes VI to X, and Class XI and XII syllabuses are developed by Higher Secondary Council. (Is it the uniform picture in all States? What are the mechanisms followed by different States? How many States follow nationalised syllabus, i.e., NCERT syllabus?).
5. All States and UTs may either adapt or adopt materials developed by NCERT. Some States have taken up some materials. (Which are the States and UTs that follow NCERT material? How do they follow it?).
6. There are well defined national goals, educational goals, curriculum objectives and subject objectives But textbooks are loaded with information, which is claimed to reflect the contemporary nature and rigour of the discipline. (Is there any study analysing the textbooks to ascertain whether they fulfill the selected objectives?)
7. When the 10 plus 2 system was introduced, the two years of old Intermediate was transferred from college to the school. During implementation, this +2 stage was taken as the base for the higher studies and Classes IX and X were considered as the base for XI and XII. It was forgotten that Classes IX and X were the climax of general education and the total of ten years of general education was the base for XI and XII. For this reason, the students of Class IX and X had to go through the details of all subjects as if they were going to join the higher studies in all those subjects. (How far the science curriculum of Classes IX and X meets the objectives of science for all students?).
8. The constraints of transacting curriculum are well known. Some of these are: crowded classrooms, poor physical facilities (library and laboratories), poor training of teachers, overemphasis on examination, etc. While framing syllabuses and developing textbooks, these constraints are rarely taken into consideration. The result is that an apparently well-designed curriculum is often condemned as heavy or loaded. (Is there any study about the curriculum load? Has there been any effort to suggest alternate transaction mechanism to overcome the constraints?).

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* The reader is welcome to add more points to this list.

9 The language of the science textbooks (English, Hindi and Regional languages) is often more difficult than the language textbooks of the same class. (Is it true? Is there any study? There are innumerable studies in other countries about reading ability—Do we have similar studies in our country?).

10. Textbooks are overburdened with facts, figures and data. In order to minimise the volume of the textbooks, clarity has often been sacrificed for brevity. (Earlier, NCERT had developed guidelines for writing textbooks. How far NCERT has followed these guidelines in its own textbooks? Is there any study showing comparative evaluation of textbooks followed in different States?).

11. In most schools, the textbook is the only source for teaching learning of science. Teachers' contact with the world of science is also only through the textbook. In most places, the teaching is completely based on page by page reading of the textbook. (Is there any study about the extent of dependence on textbook by the teachers and students?).

12. Teaching is restricted to lecture-cum-demonstration, followed by verification type of laboratory experiments. Teachers seldom use other teaching methods which they have learnt in the pre- and in-service training programmes. Excepting blackboard, charts and models, other teaching aids are rarely used. (Is it true? If yes, then to what extent? What is the utility of the teacher's guide? Is there any study about the transaction problem?).

13. Most schools do not have laboratories up to secondary stage. Equipment is limited and insufficient. Libraries do not have sufficient number of books. In some schools, kits are provided, but are rarely used. (Is there any study regarding the use of laboratories and libraries in the teaching of science?).

14. Students have different ways of learning. In a crowded classroom, with mixed ability groups, the teacher is not able to meet the learning requirements of the individual student. (Is there any study regarding the use of alternate mode of teaching in the present condition?).

15. As the lecture method is good enough for rote learning, which is the only requirement of the present examination system, neither the teacher nor the students feel any need to learn science for attaining the fulfillment of its pre-determined objectives. (Do we have detailed information about the transaction in the science classrooms of our country?).

16. A small proportion of students are encouraged to take advantages of national talent examination, State/national level science exhibition, olympiads, etc. It is, therefore, extremely difficult to identify and nurture creative and talented students. (Is there any study about identifying and nurturing gifted students in our country?).

17. Evaluation basically has remained subjective (in spite of using the format of the objective type questions) and attempts only to test the memorisation and rote-learning ability. Nothing is practically done to test the fulfillment of other predetermined objectives. (Is there any study on testing affective domain objectives in our country?).

What is to be Done to Improve Science Education?

Well, even if we cannot define the problems in empirical terms, it is evident that they are enormously diverse in nature and stupendous in magnitude. Naturally, there is no single, one-stroke solution. A comprehensive approach, therefore, is necessary encompassing all areas of our activities. Actions are required in the areas of:

A. *Research:* Education today is based on the combination of discipline (i.e., subject), experimental psychology and sociology. We are trying to improve science education from the sixties i e., almost simultaneously with USA and UK, but our materials have remained only discipline oriented. We need research-based information on all the three areas: 1) Social context for educational institutions 2) Nature of the teaching process and 3) Child's physical growth specially intellectual development.

B. *Development:*Development should be based on research findings. In the absence of that we shall never be along the prescribed lines of curriculum development (Tyler, 1950). A review of the work done in the development of national level material indicates that up to the development of syllabus, we were on the right track. But always a defective mechanism crept into the process of development of textbooks. It happened repeatedly and for this reason our textbooks of several generations are in the similar state. Innovations attempted at lower primary (Environmental Studies), upper primary (Learning Science) and secondary (Science) could not be tested and improved properly.

C. *Training:* Researches are required also to enrich teaching process. Training must equip a teacher to design his/her own teaching plan on the basis of the enrichment and learning ability of the child. Ability to go for alternate strategy to create teaching learning situation and ability for necessary innovation and improvisation must develop in a teacher. The pupils learn only through information obtained through all the five sense organs. The duty of the teacher is to present the information properly so that in the mind of the pupil it is transformed into knowledge, develops awareness and brings a sense of participation

D. *Extension:* The demand from the community has always been a great force which influenced the science curriculum. In our country this demand is only for examination result More extension activities are needed to create demand in the community for right type of science education. It is possible to create interest in science in all types of environment. The different activities undertaken towards the popularisation of science have shown positive results. But we are to go a long way towards the development of scientific literacy. Our efforts to take science to all students must be extended to all the members of the community.

While planning all those activities mentioned above, it would be important to remember that:

1. Education must be democratized. Equal opportunity of education must be available to all children irrespective of manifold differences between them. Beyond the right to "enrolment", every child must have appropriate "transaction" facilities for learning.
2. Total planning of education is necessary. The existing patchy efforts to improve here and there should be replaced by a total plan from primary to higher education.
3. Qualitative improvement must not be lost sight of while striving for quantitative improvement.

Suggested Reading

Science Education today is a discipline which is rapidly growing and changing through research and innovations. A number of magazines, journals and periodicals are published today from different countries on science education. Even daily newspapers are coming out with supplements on education, where science education occupies significant space. Names of a few books and papers are mentioned below, which definitely is not as extensive as it should be. The names of most of the well-known UNESCO publications like "New Trends" series have been omitted here but should not be excluded by the students of science education. Science Education Newsletter of the British Council, Commonwealth Secretariat and magazines like *New Scientist*, *American Scientist* and *Times Educational Supplement* are extremely useful. The educational supplement of Hindu and UGC sponsored journals of Physics, Chemistry and Biology Education are quite thought provoking. The materials which may be useful to the persons interested in science education but not directly associated with it is marked

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Identification of Misconceptions Related to Work and Energy Among Students

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Physics learning by the students could be more effective if students are able to link 'symbolic world' of physics with their 'life world' of experience outside classroom.

Many studies have been conducted in the recent past related to energy. Some are enthrographical in nature (Watts, 1983; Watts and Gilbert, 1983; Duit, 1983) and provide the conceptual map of students about energy. The other category of studies deals with teaching of energy, its conservation and other related aspects (Black and Solomon, 1985; Driver and Warrington, 1985; Urevbu, 1984). On the basis of students' thought on different aspects of energy, Brook and Driver (1984) suggested a teaching strategy for developing students' concept of energy. Duit and Orpaz (1983) suggested a five-stage programme for teaching 'energy' in the schools. In comparison, there are fewer studies on 'work' (Archenhold, 1982; Saxena, 1989b). The present work is a part of a comprehensive study to identify misconceptions among physics students related to basic concepts in physics. Misconceptions related to 'motion' have been reported separately (Saxena, 1989a). Both these studies are conducted at senior secondary (Standard XII) and at undergraduate levels.

Plan of Study

In this study, the technique used is similar to the one used earlier (Saxena, 1989a). The unit 'Work and Energy' was conceptually analysed. Table 1 provides the major concepts and their interrelationship to this unit that were taken up in this study. On this basis, a questionnaire (Appendix 1) was developed consisting of eleven situational questions. Each question has three/four possible answers and students were required to choose one. The students were also asked to write down the possible reason for choosing a particular response. The reasons given by students were

TABLE 1
Conceptual Framework of Unit 'Work and Energy'

Basic elements	Important related concepts
Energy	Conversion from one form to another Conservation Relationship with work
Work	Relation with force Calculation of work — in gravitational field — stretching an elastic body

later analysed as these provided the basis for identification of the misconceptions. The arguments given in favour of right response were also included in the analysis for they helped in the identification of misconceptions.

The concepts included in this study are related to Standard X and are fundamental to the understanding of physics. The study was conducted at different levels of education including senior secondary Standard XII and undergraduate. The students were in six groups, and their details are given in Table 2. The students came from different parts of two states, Madhya Pradesh and Orissa. No selection was made for the purpose of the study. All the students who were attending the respective courses were administered the questionnaire. The student population consisted of both boys and girls. However, sex was ignored in

TABLE 2

Group	*City*	*Level*	*No. of students*
Group 1	Bhopal	XII	94
Group 2	Amla	XII	14
Group 3	Bhopal	B.Sc./B.Ed. I*	26
Group 4	Bhubaneswar	B.Sc.(Pass)/B.Ed. I*	31
Group 5	Bhubaneswar	B.Sc.(Hons)/B.Ed. I*	13
Group 6	Bhubaneswar	B.Sc.(Hons)/B.Ed. II*	13

* These are four-year integrated courses of science and education at undergraduate level.

TABLE 3
Percentage of Right Responses

RR (RR with CA)	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
Question 1	37.2	71.4	57.7	64.5	76.9	92.3
Question 2	51.1	64.3	38.5	58.1	76.9	76.9
Question 3	45.7	50.0	50.0	67.7	46.2	53.9
Question 4	14.9	35.7	53.9	32.3	53.9	53.9
Question 5	14.9	14.3	19.2	22.6	30.8	15.4
Question 6	76.6	92.9	80.8	71.0	53.9	69.2
Question 7	25.5	35.7	15.4	25.8	38.5	23.1
Question 8	36.2	42.9	61.5	19.4	53.9	23.1
Question 9	22.2	42.9	15.4	32.3	53.8	53.8
Question 10	27.7	28.6	38.5	9.7	53.8	30.8
Question 11	46.8	42.9	26.9	48.4	69.2	92.3

TABLE 4
Percentage of Correct Arguments

	Group 1	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
Question 1	7.5	7.5	3.8	9.7	7.6	15.4
Question 2	20.2	50.0	19.2	22.6	30.7	53.9
Question 3	24.5	42.9	26.9	38.7	23.1	38.5
Question 4	8.5	28.6	30.7	25.8	53.9	53.9
Question 5	2.1	7.1	0.0	6.5	0.0	7.7
Question 6	31.9	71.4	57.7	48.4	53.9	46.2
Question 7	6.4	7.1	3.9	9.7	38.5	7.7
Question 8	22.3	21.4	34.6	9.7	23.1	23.1
Question 9	12.8	35.7	0.0	9.7	30.8	38.5
Question 10	13.8	7.1	7.7	6.5	30.8	7.7
Question 11	20.2	21.4	15.4	16.1	38.5	76.9

the analysis of the responses. Sufficient time was given to students to answer all the questions. A period of forty five minutes was found to be sufficient for this purpose.

Analysis of Responses

Table 3 shows the percentage of right responses (RR) obtained for each question. Table 4 shows the percentage of students who were able to provide correct argument (CA) in support of the correct choice made by them. As observed earlier (Saxena, 1989a) a comparison of Tables 3 and 4 shows that a large fraction of students are able to choose the right response but are not able to support it by correct argument. This shows superficial learning of concepts. Moreover, the percentage of students that is able to choose the right response is not encouraging in many cases, and related misconceptions need to be attended to. After these general comments, the responses to each individual question are discussed in detail.

Question 1

This question cites a simple situation that is observed in everyday life. Although a large percentage of students is able to choose the right response (Table 4), yet most of them are not able to explain the phenomenon. However the statements like,

> "from the law of conservation of energy, energy is neither created nor destroyed"

have not been considered as correct argument, for these do not show the deeper understanding of conservation of energy in the process. Table 5 shows the percentage of students who explicitly state that energy is destroyed because the body comes to rest. The statements claiming this are such as:

> "after coming to rest, its velocity becomes zero, hence kinetic energy is zero".
>
> "when body comes to rest, its velocity becomes zero, so the kinetic energy is completely destroyed".

TABLE 5

	Group 1	Group 2	Group3	Group4	Group5	Group 6
Completely destroyed because velocity zero	14.9	21.4	19.2	9.7	7.7	7.7
Partly destroyed	36.1	7.5	19.2	16.1	15.4	0.0

At the same time, many students think that the energy is partly destroyed:

> "energy cannot be destroyed but due to some type of friction little part of energy is destroyed and other part is converted into other forms like heat energy".

> "because due to friction some energy is destroyed and some is converted into other forms".

This shows that many students think that energy is destroyed due to friction and/or energy depends on observable characteristic (velocity).

Question 2

Although in all the groups, except group 3 majority of students are able to choose the right response, many are not able to give the proper explanation for it. However, it is difficult to give its reason, because most of such students have not written any reason in this case.

The most common wrong response is "potential energy of the arrow is converted into kinetic energy". The percentage of such students in different groups is 22.3, 21.4, 19.23, 12.9, 23.1 and 15.4 respectively Its explanation comes in this form:

> "at first potential energy is maximum and kinetic energy is zero, but when (arrow) left the former becomes zero and is converted to kinetic energy"

It has reminiscence of "conversion of potential energy of a falling body into kinetic energy".

Question 3

In this case, about half of the students are able to choose the right response. However, many students 44.7, 28.6, 15.4, 25.8, 15.4, 38.5, per cent respectively think that state 1 has higher energy. Many students argue that state 1 is more compact/compressed hence it has more energy:

> "because there is 'close' winding in state 1".

> "internal energy is always more when the molecules are close to each other".

The other common reason for this is like the following:

> "because in the state 2 some energy is lost due to stretching".

In some other cases, students think that in stretching the spring does the work, therefore 'state 2' has less energy than 'state 1'. Apart from this, some students think that energy remains the same in both the states "as stretching has no effect on the energy of the spring".

Question 4

This question requires simple calculation using $W=Fd\cos\theta$. The analysis of the responses shows that a large percentage of students forget 'cos θ' factor and hence arrive at response '100' The percentage of such students in various groups is 70.2, 64.3, 34.6, 61.3, 30.8, 28.5 respectively, out of which 53.2, 42.8, 26.9, 51.6, 30.8 and 28.5 per cent students (of the total) write the formula $W=Fd$. This is perhaps due to wrong introduction of the mathematical concept of work as the product of force and displacement. (Balasubramanian et al., 1988; White, 1987). Once a concept is formed, it is difficult to modify it (Driver and Erickson, 1983).

Question 5

In circular motion the centripetal force and displacement are always mutually at right angle. It is for this reason that work done in any part of the revolution is zero. Many students do not realise this. It is reflected in the percentage of students who give the right response. Table 6 provides percentage of the two incorrect responses A large percentage of students calculates the work done as the product of force and displacement. If they take centripetal force mv^2/r as the force they arrive at response (i) and if they take weight mg as the force (though erroneously) they arrive at response (ii). These results support the conclusion drawn with reference to question 4

Question 6

This question also requires the calculation of work done. Sometimes it is suggested that students should also be presented with problems where they have to decide what relevant information is (Driver and Warrington, 1985). This question and question 7 contain some extra information and students have to choose the appropriate information. We have found that many students have been misled due to this extra information. Table 7 shows the percentage of students who think that Ram does more work. It also shows the percentage of students who explicitly state that this is due to shorter duration in which he is able to complete the work. It appears that students are not able to differentiate between power—rate of doing work—and total work done.

Question 7

Apart from selection of the relevant information this question requires the use of conservation of energy. Driver and Warrington (1985) have reported that students tend to interpret in terms of observable characteristics such as force, displacement rather than principle of conservation of energy. In this question our experience is also

TABLE 6

Percentage of students	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
$\frac{mv^2}{r}\cdot\pi r$	45.7	78 6	38.5	51.6	61.5	76.9
$mg\cdot\pi r$	27.7	0.0	15.4	6.5	7.6	7.6
Work = Force × distance (in response i and ii)	23.4	35.7	30.7	32.3	53.8	76.8

TABLE 7

Percentage of students	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
Ram	25.5	7.1	15.4	22.6	46.2	30.8
Due to less time	18.1	7.1	11.5	12.9	7.7	23.1

TABLE 8

Percentage	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
Same temperature	48.9	50.0	30.8	64.5	38 5	61.5
Same temperature as thermos is insulated	29.8	50.0	23.1	64.5	30.8	61.5

similar. Very few students are able to give the correct response and provide the right argument for it. In every case except one (group 5) the percentage of such students is less than 10 (Table 4). Most commonly it is found that students calculate the work done by multiplying weight by the distance moved, which is in terms of, though wrongly, observable variables.

Question 8

The concept of temperature is elusive to the students and they are not able to correlate this with molecular energy. For this reason, presumably, a large fraction of students think that temperature of the thermos will remain the same (Table 8). Out of these most of them explicitly state that this is because the thermos is insulted. This is reflected in statements such as:

> "we know that there is no change in temperature inside the thermos".

> "because neither the heat goes outside nor comes inside".

Only a few students give a clear explanation as

> "the kinetic energy of molecules increases resulting in increase in heat inside the thermos flask".

Question 9

Like question 1, question 9 also judges the concept of conservation of energy. In this case the most prominent response is conversion to potential energy. The percentage of students stating this in various groups is 48.9, 25.7, 46.2, 38.7, 38.5, and 38.5. It appears students use the term potential energy without understanding its meaning (McDermott, 1984). The analysis of responses for question 1 becomes relevant in this context. Some students also state that energy is completely destroyed because the ball finally comes to rest. This remark is similar to the argument that the energy is destroyed because body comes to rest (question 1).

Question 10

Pendulum and its motion is familiar to the students of science. Yet very few students give the correct response in this case (Table 3) and still fewer are able to explain this on the basis of conservation of energy. This is in agreement with the observations made with regard to question 7. Many students presume that point C is the correct response because it is on the farthest side to the right and compare this with their observation of a pendulum

Question 11

The concept of energy with the observable quantity velocity is again reflected in this case. Though a large percentage of students choose the correct response (Table 3) yet in most of the groups about half of them (Table 4) are able to justify it scientifically. The reflection of 'velocity' is observed in the fact that 30.9, 50.0, 53.9, 12.9, 23 0 and 7 7 per cent students respectively feel that the toy car has maximum velocity when it is in motion. About fifty per cent of these explicitly state that this is due to velocity of the car:

> "because the car will have more velocity hence maximum energy".

> "the energy of the car is due to its motion".

Brook and Driver (1984) observed that one in ten students state the dependence of energy on velocity. Only few students give statement like this:

> "since the completely wound spring provides the sufficient kinetic energy to the car so as to move".

Discussion

Analyses of different kinds of responses and arguments given in their favour give us an idea of the possible misconceptions that could exist among students, who had more than eleven years of schooling. At the same time, it is also realized that these misconceptions have different frequencies, depending upon the socio-cultural background of the students. Despite this some common misconceptions could be identified which occur with varying frequencies in different populations. These possible misconceptions are as under:

1. Energy of a body is destroyed completely or partly when it comes to rest. This could be due to friction.
2. When a body moves, its motion is due to change of its potential energy to kinetic energy
3. A body in compact form has higher energy.
4. Work done by a force is the product of force and displacement, irrespective of the angle between them.
5. Work done depends on how fast it is done.
6. Temperature is the inherent characteristic property of the substance, it does not change by working on it.
7. A moving body has more energy than when it is at rest. Apart from these misconceptions, it is also observed that observational properties influence the students to draw the conclusion, rather than the abstract principles.

Implications

There are many words like work, power, energy which have different meaning in everyday observation and in physics. Black and Solomon (1985) group these two different meanings related to 'life world' and 'symbolic world'. The former meaning is related to and is reinforced by our life experiences. The latter meaning is related to physics/science and is confined to its scope only. Accordingly, physics learning by the students could be more effective if students are able to link 'symbolic world' of physics with their 'life world' of experience outside classroom.

This does not imply replacement (Brook and Driver, 1981) of the meaning in the context of life world by the meanings in the context of science but help the students to modify the conceptual framework such that they are able to choose the appropriate meaning according to context.

The results reported here are similar to another study (Saxena, 1989b) conducted on teachers. This would imply that a more careful planning will be required to deal with the concepts of work and energy. This programme would include the training of teachers to help them clarify their concepts and modify these to make them scientifically acceptable.

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Appendix 1

Name: ________________________________

Instructions: 1. Tick (✓) the most suitable answer.

2. Explain the reason for making the choice.

(Right responses are marked with asterisk *)

1. A body falling with velocity 2 m/s comes to rest after striking the ground. What happens to its kinetic energy?
   i) It is completely destroyed.
   ii) It is partly destroyed and partly converted into other forms.
   iii)* It is completely converted into various forms
   iv) (any other).
   Reason ____________________________

2. An arrow is thrown by a bow with velocity 3 m/s. What is the source of its kinetic energy?
   i) The potential energy of arrow.
   ii)* The potential energy of compressed bow
   iii) Gravity.
   iv) Reaction to the pressing of the air.
   Reason ______________________________

3. Figure 1 shows a spring in two states. State 1 shows normal state of the spring and state 2 shows its stretched state. Which statement is true about its energy?
   i) The energy in both states is the same.
   ii) The energy in state 1 is more.
   iii)* The energy in state 2 is more
   Reason ______________________________

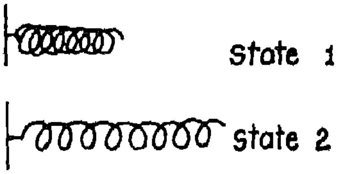

Fig. 1

4. A force of 20 newton is applied along a rod *AB* to displace a stone of mass 2 kg by 5 m in horizontal plane (Fig. 2). What is the work done, if the surface is frictionless?
   i) 10 g Joule.
   ii) 100 Joule.
   iii)* 50 Joule.
   Reason ______________________________

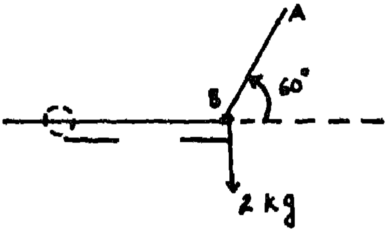

Fig. 2

5. A satellite is revolving round the earth with constant speed v (Fig. 3). What is the net work done in half revolution?
   i) $\frac{mv^2}{r}\cdot\pi r$
   ii) $mg\cdot\pi r$
   iii)* zero.
   Reason ______________________________

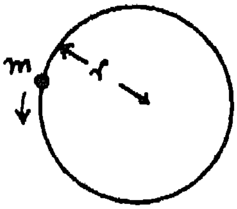

Fig. 3

6. A heavy stone of mass *M* is lifted and kept on the raised platform. Ram does this in 5 seconds and Shyam does this in 10 seconds Neglecting air friction, which statement is true?
   i) Ram does more work.
   ii) Shyam does more work.
   iii)* Ram and Shyam do equal work.
   Reason ______________________________

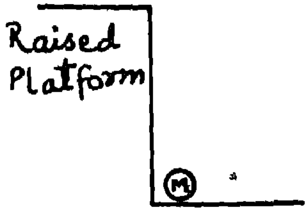

Fig. 4

7. A ball with velocity 10 m/s and mass 0.2 kg penetrates the sand and comes to rest after travelling 5 cm in the sand. What is the work done by the sand. (Neglect temperature changes).
   i) Zero.
   ii) 50 Joule.
   iii) .098 Joule.
   iv)* 10 Joule.
   Reason ____________________________

8. A sealed and perfectly insulated thermos with coffee inside is shaken vigorously. What will happen to the temperature of the coffee?
   i)* Rise.
   ii) Fall.
   iii) Remain same.
   Reason ____________________________

9. A ball rolling on a horizontal floor stops after moving some distance. Which statement is true about its kinetic energy?
   i) It is converted into potential energy of the ball.
   ii) It is completely destroyed.
   iii)* It is converted into heat and other forms of energy
   iv) It is partly destroyed and partly converted into other forms of energy.
   Reason ____________________________

10. A bob hanging as simple pendulum is taken to position *P* (Fig. 5) and released (no force applied to the bob while releasing). Up to which position is it most likely to go? (Neglect air friction).
   i) *A*
   ii)* *B*
   iii) *C*
   Reason ____________________________

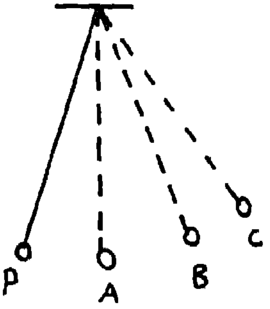

Fig. 5

11.†There is a toy car with winding spring. A boy winds the spring completely and lets the car go. The car moves a certain distance and stops. When had the car maximum energy?
   i) Before winding.
   ii)* When the spring was completely wound.
   iii) When the car was in motion.
   iv) When the car finally stopped.
   Reason ____________________________

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† Based on Brook and Driver (1984).

Cognitive Preferences in Operation: An Example

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A teacher taking up a unit for discussion in the classroom reflects his teaching preference during the course of his teaching. Instead of stating only cold and dry facts and rigid theories, classroom milieu may be made alive and dynamic by presenting factual scientific information in its varied connotations. This is certainly not to suggest that teaching depends only upon individual idiosyncracy, and teacher will teach certain things and leave others simply because he does not like them

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Cognitive-preference tests first introduced by Heath (1964) have been increasingly in vogue up to the present times "It is not an attempt to measure whether the student can identify correct or incorrect information, but rather what he is likely to do with information intellectually" (Heath, 1964). According to Harris (1974, p. 86), "most of the achievement testing in schools focuses on the 'can do' class of behaviours ... these are the knowledge, skill, ability types of objectives. But there may be other objectives, the achievement of which is evidenced by what the student typically does do These are the attitude, interest, cognitive style types of objectives—perhaps more affective than cognitive". Cognitive preferences constitute a kind of cognitive style that deals with attributes of special relevance to the learning of science and science related subject matter (Tamir and Jungwirth, 1984). Tamir (1977) considered cognitive preferences as a variant of cognitive style. Cognitive preferences occupy a middle position on a cognitive-affective continuum (Tamir, 1976).

Bruner (1960) suggests that in the new courses emphasis was put on "a firm understanding of basic ideas that permeate the discipline rather than on technical vocabulary and practical applications".

In recent times, Indian education especially school science education has been the scene of considerable reform. The National Policy on Education (NPE) 1986, clearly states that science education will be strengthened so as to develop in the child well-defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question ... The science education programmes should be designed accordingly to enable the learner to acquire problem-solving and decision-making skills and to discover the relationship of science with health, agriculture, industry and other aspects of daily life (NPE, Government of India, 1986, p. 23). Intended curriculum objectives can become achievable objectives only when these are translated in the intended direction. This largely depends upon the teachers. The unique position of the teacher in our educative processes is further strengthened by the aptly made statement in NPE, 1986:

> The status of the teacher reflects the socio-cultural ethos of a society; it is said that no people can rise above the level of its teachers (p. 25).

It can be well argued that bringing changes in the curriculum and syllabus to revitalise the school education will remain useless so long as the teacher does not change himself, i.e., you change the syllabus and the textbooks but the teacher will teach only what he knows and prefers, so he moulds the system according to his own convenience. In Challenge of Education (Government of India, 1985), it is stated "whatever policies may be laid down, in the ultimate analysis these have to be interpreted and implemented by teachers, as much through their personal example as through teaching-learning processes" (p. 55). The sponsors of BSCS in USA were fully aware of the pivotal position of the teacher, as epitomized by the statement (BSCS, 1962) that the BSCS fully recognises, that merely providing new curricular materials, however good they may be, will not necessarily result in improved biology teaching in secondary schools. It may facilitate improve teaching, but the teacher remains the key. Similarly, National Policy on Education, 1968 (p. 2) also says: "of all the factors which determine the quality of education and its contribution to national development, the teacher is most important".

All these lead us to suggest that cognitive preferences of teachers are of particular importance for improving instructional practices such as matching the students to teacher and the teaching method or fostering of alternative modes of cognition and stylistic approaches to problem solving. With the inception of cognitive preferences many evaluation studies were undertaken in connection with students and some with teachers Because of the ideographic nature of the evaluation studies that have been undertaken, a need is felt to cite an example how cognitive preferences operate in teaching-learning situations. This will provide a necessary ground work for understanding the ideas associated with cognitive preferences to secondary school teachers the consumers of our researches to improve classroom practices without which theory may find itself detached from reality.

It is felt that some discussion regarding how teachers' cognitive preference affects teaching is imperative to avoid unnecessary complication before taking up examples of cognitive preferences in operation.

A teacher taking up a unit for discussion in the classroom reflects his teaching preference during the course of his teaching. Instead of stating only cold and dry facts and rigid theories, classroom milieu may be made alive and dynamic by presenting factual scientific information in its varied connotations. This is certainly not to suggest that teaching depends only upon individual idiosyncracy, and teacher will teach certain things and leave others simply because he does not like them. Rather, the excellence of the teacher's performance becomes, at best, apparent while he takes up certain aspects of knowledge and quite likely the identical behavioural norm of students get reinforced. Succinctly, although teacher puts his effort to cover the whole gamut of curriculum or syllabus, he spontaneously shows his preference for certain aspects of knowledge over others which automatically foster identical learning.

Different Types of Cognitive Preferences

The four modes of "attending to scientific information" originally suggested by Heath (1964) are given here as reformulated by Van den Berg et al. (1978):

Factual Information or Recall (R). Acceptance of scientific information for its own sake, i.e., without consideration of its implications or application. A preference for Recall indicates an interest in learning a name, a number, a definition, a formula, an observation, or a fact.

Principles (P): Representation or explanation of fundamental scientific principles. A preference for principles indicates an interest in identifying a relationship between variables, or a rule that can be applied to a class of objects, organisms, phenomena, or variables, or an interest in explaining phenomena.

Questioning (Q): Critical questioning of information for completeness, general validity, or limitations A preference for questioning indicates an interest in critically analyzing and commenting on the validity of scientific information and/or in generating suggestions and hypotheses for further research.

Application (A): Application of scientific information in problem solving in real life situations: general, social and scientific context. A preference for application indicates an interest in using scientific information to solve problems in commerce, industry, farming, or in daily life

Sample Item

A typical test item comprises a heading referring to a topic and is followed by four alternatives each of which refers to the general topic, and is representative of one of the modes mentioned above. A sample item is quoted below:

The nervous system is an organized network of cells and fibres which accepts stimuli, reacts to them and regulates the activities of various organs in the body.

A. All impulses have a similar nature which may be characterized as electro-chemical. (P)

B. A normal nerve cell consists of 3 parts: the cell body, axon and dendrites. (R)

C. Do nerve cells undergo mitosis like other cells? (Q)

D. The knee reflex is used as an indicator of the adequate functioning of a human nervous system. (A)

The above item (S.No 6) was taken from the Combined Cognitive Preference Inventory (CCPI) compiled by Pinchas Tamir (See Tamir, 1976).

Cognitive Preferences in Operation

I. Teaching of Sample Items

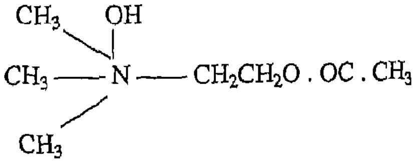
Recall

1. *Description of:* Nerve net, nerve cell, synapse, receptor cell, sensory neuron, reflex arc, reflex action, chemical composition, etc
2. *Definition of:* Stimulus, polarization, threshold stimulus, conditioned reflex action, neurohormone, all-or-none response, etc.
3. *Name:* Name the different parts of human brain etc. Name the person who discovered conditioned reflexes, studied nerve impulse.
4. *Number.* Number of cranial nerves in frog and human brain. Nerve fibres that possess myelin sheaths transmit impulse at the rate of 120 metres per second.
5. *Giving Physical and Chemical Formula*
   (i) *Physical Formula.* Conduction velocity of a bundle of nerve fibres can be studied by stimulating the nerve bundle at one end and recording compound action potential at the other If the length of nerve in mm from the placements of the stimulating electrodes to the recording electrodes is noted (L) then the conduction velocity V (m/sec) can be calculated.

$$V = \frac{L}{l}$$

where L is the length of the fibre in mm and l is the latency of action potential in m/sec.

(ii) *Chemical Formula.* Chemical formula of acetylcholine molecule:



Principles

1. The physiological properties of the nerve fibre vary with their diameter and medullation. The thicker the nerve fibres, the higher will be the impulse velocity, the lower will be the refractory period and stimulus threshold.
2. Although along the length of the nerve fibre impulses can travel in both the directions; however, under normal conditions the nerve impulse travels in one direction only—in the motor nerve towards the responding organ; in the sensory nerve towards the centre. This is due to the action of 'synapse'.
3. There is a period of time in man after the spinal cord has been severed when spinal reflexes seem to stop. For as long as six months the body seems to be completely paralyzed below the region where the spinal cord was damaged. Only very gradually do movements begin to reappear in response to stimulation of the skin in lower part of the body. Eventually the flexion reflex becomes very vigorous again. The long period before the reflex reappears is interpreted to mean that normal function of the spinal cord is dependent on the constant transmission of controlling messages from the brain. The spinal cord seems to need a long time to adjust to the loss of brain impulses Although a similar situation exists in other animals, the spinal cord of man is more dependent because of the greater control from his relatively large brain. This is also obvious from the large amount of spinal cord space devoted to ascending and descending tracts that the brain exerts an important controlling influence over the segments of spinal cord.
4. If the stimulus is stronger than threshold, impulses will not travel any faster or be any stronger. Under normal conditions all impulses generated by equal to or above threshold stimulus travel along the neuron, at the same speed and with the same strength, the reason being the energy for conduction of the impulse comes from the neuron itself and not from the stimulus.
5. Nervous regulation and chemical or hormonal regulation are basically similar, no matter how unlike they may seem at first sight.
   (i) S → G → blood vessel → sensitive tissue
   (ii) S → N → sensitive tissue
   (iii) S → N → G → sensitive tissue
   (S is stimulus, G is gland, N is nerve)
   Methods of effecting nervous and hormonal control are thought to be somewhat similar as all of them involve in the transmission of chemical substances.
6. Recently evolved organism as compared to its primitive forms has more developed and advanced nervous system and, therefore, the man's brain sets him apart from all other animals. If we move along the evolutionary scale starting with certain protists and then the hydra and other coelenterates and finally the mammals and human being, the nervous system is gradually more and more differentiated and organized
7. The impulses that reach the brain by way of the sensory neurons are all the same. Those from the eyes, the ears, and the pain receptors are identical. It is in the brain that the sensations of seeing, hearing, tasting, smelling, and feeling are experienced
   Neurons can be stimulated to carry impulses by touching them. For example, if a neuron from the eye is touched there would be a sensation of seeing. Similarly if a neuron from the ear is touched there would be a sensation of hearing. Now suppose if the nerve from eye to brain is detached from the eye and connected to the receptor cell of the

ear when under such case music is listened one would have the sensation of seeing—not hearing. All these exemplify the functioning or role of the brain in relation to various sensory receptors.

8. A child who is born deaf is also born dumb. The speech is the production of articulated sounds always bearing a definite meaning. Like all complex motor processes, the speech is brought about by the highest faculties of brain by the co-ordinated activities of a number of sensory, psychic and motor areas. When a baby learns speaking, it at first hears the sound of a spoken word. For speech, therefore, hearing is essential.

Questioning

1. There are no special nerve cells in plants and unicellular animals, but these organisms exhibit responses that may spread beyond the stimulated point. The sensitivity of these cells to stimuli indicates that response to stimuli is a general characteristic of most tissues. However, in case of higher animals this is brought about by specialized nerve cells called neurons. How do you explain that such division of labour has a very high evolutionary significance?
2. What evidence shows that control by the nervous system is important to muscles?
3. It seems so obvious to us that even with our eyes closed we could know the position of our limbs—whether they are outstretched or at our sides. But suppose you have to explain this fact to a native of a primitive island. How do you do it convincingly?
4. Spinal cord is a hollow structure. Had it been a solid, what would have happened?
5. Presence of central nervous system has a special advantage in case of higher animals. What arguments can you advance for the idea that these advantages have led to the evolution of man and sets him apart from all other animals?
6. In spite of the presence of withdrawal reflex a tight rope walker on stepping on some sharp object, can retain the posture needed for proper balance. Explain.
7. Interpret the following observations:
    1. A person who cuts off a snake's head can later be bitten by the snake's head.
    2. A headless snake is able to wriggle.
    3. A headless chicken is able to run.
8. In addition to the brain controlled activities of which we are aware what advantage might the brain provide to us by controlling a whole range of activities without our conscious knowledge?
9. If all impulses travel at the same speed and are of the same strength, how can a nerve fibre cause different strengths of response?

Application

1. Like other cells, nerve cells also show changes of electrical potential during activity. There is a more or less rhythmic increase and decrease of electrical activity in the brain. These measurable electrical changes or 'brain waves' give evidence of brain activity. With an instrument called electroencephalograph the waves can be detected, amplified and recorded. Such a record is called electroencephalogram (EEG). Changes in the brain activity have been noted (EEG) in certain diseases like cerebral tumours, meningitis, epilepsy etc. EEG is now widely used for measuring brain activity for the diagnosis and investigation of impaired cerebral functions, head injury, etc.
2. Studying reflexes has great importance in clinical diagnosis of certain diseases of central nervous system.

3. Understanding the properties of nerves helps us to develop drug like tranquilizers and sedatives.
4. Apart from other physiological changes it has been noted that galvanic skin response and some other electrical property of the nervous system changes under emotional stress condition This property is used in lie detector, although less popularly, to detect lies told by human subjects.
5. Most of our habits are conditioned reflexes. Hence, it is of immense personal and social importance. It has great applied value in clinical and psychological medicine With the help of conditioned reflexes cerebral centres can be localised.
6. There is now evidence that certain mental diseases may be caused by upset brain chemistry. The chemical approach to the study of nerve function is important for the fundamental understanding of nervous system. This approach is revolutionizing the study of mental diseases. Perhaps one day some mental diseases will be treated with specific chemical substances, just as the bone disease, rickets, is now treated with vitamin D
7. The regulation of heart beat is brought about by an accelerator nerve and inhibitor nerve with the release of chemical substances. This knowledge helps us to revive a dying heart by stimulating accelerator nerve or by using appropriate chemicals.

II. Achievement of Pupils

Studies have opined that the role of the teacher in setting the intellectual tone of the pupil is an important factor in determining pupil achievement. The outcome or achievement of the pupil is a function of many variables. The pupil with his complex social structure and kaleidoscope of cognitive and psycho-sociological variables, cannot ignore the key place of teacher in teaching-learning situation in influencing their intellectual behavioural disposition. Although teaching in the classroom largely depends upon the nature of the curriculum and syllabus, the objective to be achieved, however, the essence of teaching is how ideas are presented. The presentation of idea and information is intimately connected with the teachers' own mode of preferences for different types of intellectual tasks. With the result, within the framework of curriculum and syllabus different blends in teaching can be seen and we often hear the statement that teaching is an art An artist not only reproduces what we see, he makes us see things. Similarly a teacher does not come in the classroom only to impart knowledge to achieve course objectives, rather he acts as a catalytic agent to initiate different kinds of intellectual developments among students sometimes deliberately and many a times unknowing while delivering lecture, answering and asking questions, providing discrepant situations, preparing term and examination papers, setting experiments in the laboratory, reinforcing and fostering particular kinds of intellectual endeavour and such other related activities.

In the above-cited example (Nervous System), it has been shown that cognitive preferences while in operation can be restricted only to factual information (or recall). Students exposed to such teaching cannot be expected to attend other modes of cognitive preferences, i.e., Principles (P), Questioning (Q), and Application (A). On the contrary, if the teacher during the course of his teaching takes up various aspects of scientific information representing R, P, Q and A naturally when pupils are exposed to a whole range of thought processes under such condition, pupil achievement will be affected.

Curricular Preferences—Cognitive Preferences Symbiosis

It is worth considering the development that took place in the late 1970s Popperian and Kuhnian paradigms raising the substantive issues—what are the philosophical and epistemological bases of science education, and what is the nature of scientific knowledge? Popper (1972) states:

> "Thus it seems to me that it is the tradition of criticism which constitutes what is new in science, and what is characteristic of science".

In my opinion, despite the fact that the teachers are handicapped by the syllabus, what constitutes NCERT and SCERT school science programme would be very different if the teacher educators in pre-service and in-service teacher education programme urge teachers to pay heed to the origins of modern science, to the social conditions of the Renaissance, and to the emergence of a scientific world-view in the seventeenth century. This could lead to the identification of distinct levels within science education. The totalitarian features of the scientific perspective: the mathematical, analytic and experimental all combine to develop scientific knowledge an ordered collection of objective facts and theories. Secondly, all statements and facts in science are based on theory, and there is no distinction between theoretical and observational concepts. Thirdly, even then facts and theories are not safe from refutation. Last, but not the least, is the application of science which ensured the triumphant growth of science. Understanding all these practices will make a direct impact on the prevailing cognitive preferences of teachers, and will ensure them to rise above the constraints of the syllabus and simultaneously not deviating far enough from the method favoured in the syllabus.

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A Multipurpose Coil for Experiments in Electromagnetism

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The chief difficulty in this experiment is that without any ferromagnetic material being used, the coil has to be bulky. Still its magnetic moment is very small.

The Problem

We teach in physics courses that a coil carrying direct current has a magnetic field similar to a bar magnet and thus acts like a magnet. To demonstrate it experimentally it is easy to have a coil of sufficient number of turns, pass a strong direct current (DC) through it and demonstrate the magnetic field by iron filings spread on a horizontal plane board, which has the axis of the coil in its plane. If weaker current is passed and is kept constant for sufficient time, the magnetic field can be plotted with the help of a plotting compass.

But the real thrill of demonstrating this concept is felt if the coil can be freely suspended like a compass needle and then it may align itself with its axis in the North-South direction under the influence of earth's magnetic field. This is easily accomplished if there is an iron rod inside the coil functioning as the core. But then it, in fact, demonstrates magnetisation of an iron rod by the coil carrying current. Thus the demand of the concept is that this demonstration may be done without using any ferromagnetic material.

During the development of Physics Laboratory Manual of the NCERT, it was a matter of hot debate whether such an experimental demonstration is feasible. Though those discussions were inconclusive, the strong desire of the group that we should make this demonstration possible was very much evident. A thorough search of all available literature, Indian and foreign, led to only two sources where such a demonstration was mentioned.

(1) The physics textbook for Class X published by NCERT in 1986 mentions the following design, but it is too cumbersome and costly. It utilizes a coil of 1000 turns made on a cardboard tube about 20 cm long (used for shuttle cocks). A current of about 1 ampere is passed in it by a 6-volt battery (e.g., a motor cycle battery). The whole set-up is placed in a plastic trough and floated in water (Fig. 1). It consumes about 1.6 kg of SWG 20 enamelled copper wire.

(2) Another successful but equally cumbersome experiment was attempted by Prof. S.N. Datta of Regional College of Education, NCERT, Mysore. His coil was also about as big as in (1) above. It was fed current from an external source placed on the table. The coil was pivoted inside a bell-jar to avoid air droughts.

During the workshop for development of the Laboratory Manual members wished to make this equipment smaller and less costly. Some wished to go as far as to suggest that a button cell

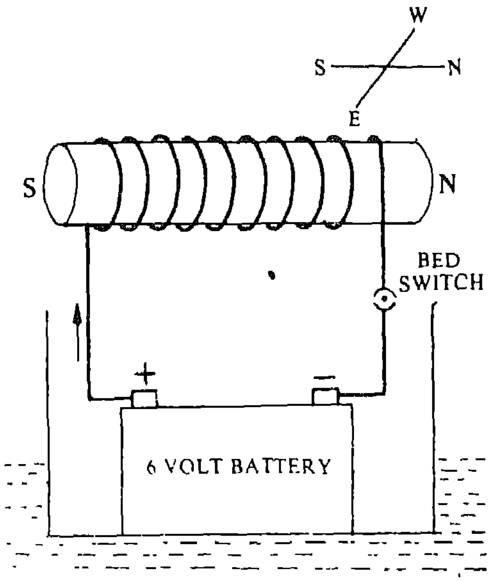

Fig. 1

with a small coil over it should be used. However, another member demonstrated that the button cell contains ferromagnetic material in it The author then consulted a talented electrical engineer in BHEL, who in his student days had designed for NSTS (National Science Talent Search) project a wick-type high efficiency kerosene oil stove which later became the forerunner of the now popular NUTAN stove.*

The chief difficulty in this experiment is that without any ferromagnetic material being used, the coil has to be bulky. Still its magnetic moment is very small. Thus following objectives were set for developing an optimum design of the coil:

1. To minimise the size and weight of the coil.
2. To maximise the magnetic moment of the coil.
3. To make efficient use of electric energy provided by a dry cell, which contains no magnetic material in it.

The Optimum Design of the Coil

The large dry cell is of cylindrical shape having a diameter of 33 mm and length of 60 mm A cardboard spool is made, in the core of which the cell just fits Thus the space for winding the coil in the spool has a length of 58 mm and diameter of 35 or 36 mm Between 500 to 600 turns are wound on it by SWG 24 enamelled copper wire It may have a resistance of between 4.2 and 5.5 ohm depending on the number of turns and how loosely these are wound. Thus the 1.5 volt cell passes a current between 350 mA and 270 mA through it (Fig 2). Total weight of the coil is under 250 gram, out of which about 90 gram is due to the dry cell itself. The coil with the cell in its core is suspended in the stirrup of a vibration magnetometer. More simply, it may be suspended in a laboratory stand using a monofilament nylon thread. This type of thread has no twists and thus it is easier to demonstrate the following steps:

(a) With no current in the coil, it remains practically stationary in any direction.†

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* An improved version of the NSTS project along with detailed description of all experiments and data was submitted to the Government of India in the competition for designing a high efficiency wick-type kerosene oil stove held in the year 1975 Based on this entry of the competition, and with minor improvement in efficiency, the NUTAN stove was developed by a public sector organisation

† Due to low torsion constant of the mono-filament nylon thread, the suspended coil oscillates like a torsion pendulum with a very large time period of about 2 minutes or 3 minutes Of course, the thread should not be too thick and should have a tensile strength of two to four times the weight of the coil and cell Another good suspension consists of a few fibres taken from unspun silk. Such number of fibres should be taken which just do not break by the weight of the coil. If the fibres spread out while suspending the coil, they act like a bifilar suspension and have a large torsion constant. Hence it is necessary to make a knot at the upper end and also at the lower end.

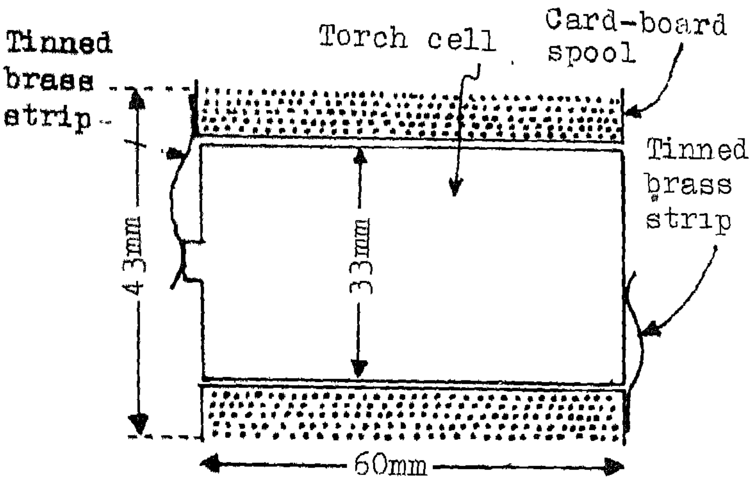

Fig. 2

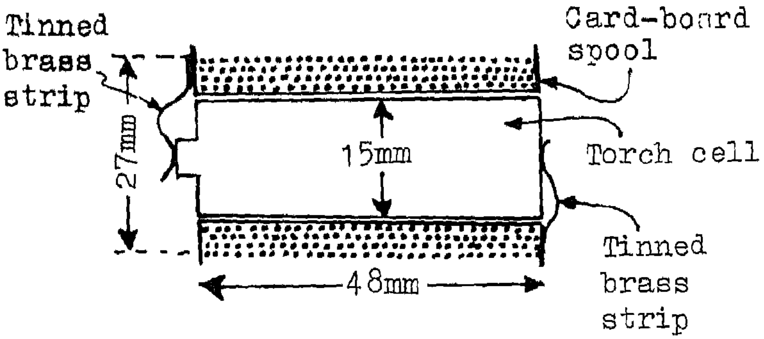

Fig. 3

(b) When the cell is connected and thus current is passed in the coil, it oscillates so that mean position of its axis is along the north-south direction. Time period of the oscillations is around 15 seconds. Thus 4 or 5 oscillations are demonstrated within less than 2 minutes.

Another version of this coil uses a medium size dry cell. The coil is made of SWG 26 enam-

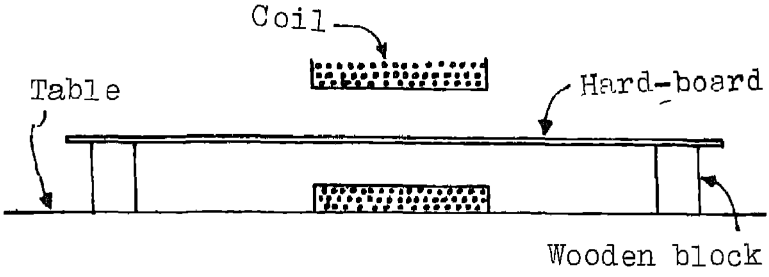

Fig. 4

elled copper wire having a resistance of between 5 ohm and 6 ohm. Third version of this coil uses a pencil cell and a coil of resistance about 6 ohm made of SWG 26 enamelled copper wire. Figure 3 shows the dimensions of the smallest version. It consumes about 57 m of wire, wound in 10 layers and weighing about 75 gram. However, the life of the pencil cell is much shorter than the other two cells.

Using any version of the coil, the experiment can be demonstrated in a simple way without encasing it in a bell-jar to avoid the air droughts, as the coil is compact and solid In case, however, there are strong air currents produced by a ceiling fan or a table fan and the fan cannot be stopped, then a cylindrical transparent wall of glass or plastic around the suspended coil is needed.

An alternative way of freely supporting the coil, without involving the elastic torsion of the thread is to place it in a small plastic trough and then float it on water in a larger trough. But, then, it is essential to take care that.

(a) The walls of the two troughs do not touch anywhere, and

(b) the coil does not get wet by water.

Multiple Uses of this Coil

(i) The coil used for the large cell can be fixed in the centre of a sheet of hard-board so that smooth surface of the hard-board is co-planar with the axis of the coil (Fig. 4). The hard-board is adjusted horizontal with the help of a spirit level Then fine iron filings are spread on the smooth surface of the hard board. A current of about 1 ampere is passed in the coil with the help of a 6 V battery for a few minutes during which the hard-board is tapped gently. Iron filing become tiny induced magnets and arrange themselves and display the pattern of the magnetic field of the coil.

(ii) In the above set-up, a steady current of about 200 mA can be passed in the coil for about 1 hour with the help of a battery-eliminator. A sheet of paper may be attached on the hard-board and then the lines of force may be plotted with the help of a plotting compass.

(iii) 19 pieces of straight iron wires, each 15 cm long and about 5 mm to 6 mm diameter (commonly used to make clothesline) are taken. These are coated with enamel paint and then tied together firmly to make a stock of cylindrical shape. This makes an iron core for the coil (the largest version). Pass a current (DC) in the coil by a 1.5 V or 2 V source. Observe the effect of passing the current on a compass needle placed at some distance from the coil, with and without the core in the coil (Fig. 5). Thus infer the effect of iron core on the magnetic field of the coil.

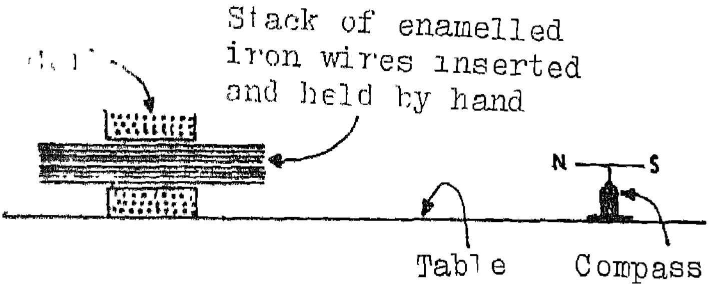

Fig. 5

(iv) Let the core stand vertical with the coil placed on the table around on it. Insert an aluminium ring with a hole of 40 mm diameter on the core. Pass an alternating current (AC) in the coil by a 12 volt AC source. Eddy currents induced in the ring make it to jump off (Fig. 6).

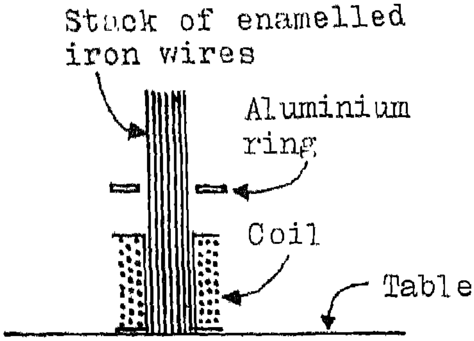

Fig. 6

(v) With the help of a magnet and galvanometer, the largest and the smallest versions of the coil can be used to demonstrate the phenomenon of electromagnetic induction and Faraday's Laws. The smallest of the three versions of the coil described above will easily slip into the largest one for this demonstration.

(vi) Any of the coils can be used as an air cored self-inductance and, with an appropriate iron core, as an iron cored self-inductance for various experiments. With various positions of the iron core, it can also function as a variable self-inductance

Acknowledgement

Thanks are due to Shri Deepak Kant of Bharat Heavy Electricals Limited, Hardwar, U P., for his expert advice in designing the coil Thanks are due to Prof V.G. Bhide for his insistence that this experiment must be possible and the various suggestions that he made towards this end. Prof. K.J. Khurana deserves appreciation for experimenting with the button cell and consultancy during the entire project. Shri T.S. Verma, Laboratory Assistant, deserves appreciation for his assistance during experimentation. Last, but not the least, workers of Workshop Department, NCERT deserve appreciation for their cooperation in fabrication work.

Planning Environmental Education at the National Level

This article is but a brief summary of a new publication by the UNESCO-UNEP International EE Programme, entitled ***Environmental Education Handbook for Educational Planners****, available in English to institutions requesting it by writing to* ***Connect*** *or to the National Institute of Educational Planning and Administration (NIEPA), 17B, Sri Aurobindo Marg, New Delhi 110 016, India*

Let us assume that national authorities have finally recognized the critical impact of environmental problems—pollution of the air, the earth and water; endangered ecosystems; the urgency of environmental solutions, and the key role of education and training in this field of national, indeed international, concern. What steps are to be taken to introduce environmental education into the national educational process at all levels and in all forms?

To begin with, a national environmental education (EE) strategy must be designed according to the specific conditions—economic, political, cultural, etc.—of the country. These form the unique combination, or framework, within which an EE planning team will perforce operate With regard to a national strategy for EE as a planning and management process, five critical factors might be listed·

- The first factor is the country's level of interest and commitment to EE—to be assessed in terms of national policies or budgets in the areas of education, environment and natural resources and also in terms of ideas and behaviour of political and educational leaders, citizens, educational practitioners and environmental professionals.
- The second key factor is the country's experience with national planning and management of educational efforts in general within which the national EE strategy must be made operational.
- The third factor necessary for designing a country's strategy is its past efforts and experiences with EE—which naturally vary widely from one nation to another.
- The fourth essential factor is the availability and potential of resources for planning and implementing the EE strategy—to be assessed in terms of leadership, implementing organizations, money and materials, skilled workers, professional and volunteer activists
- The fifth, or last, factor to be assessed is the overall situation in the nation with regard to existing barriers to, as well as favouring forces for, really effective realization of a national EE strategy and plan.

As for such a strategy and plan, six major initial actions are involved·

1. Formulation of a national policy on environmental education which clearly sets forth the country's commitment to the cause of EE and the national approach to be adopted for achieving EE goals and objectives.
2. Preparation of short- and long-term plans for realizing the national EE strategy.

3. Formulation of specific programmes for implementing the EE strategy and plan.
4. Working out implementation strategies and tactics for putting the various EE programmes into operation.
5. Creation of the necessary institutional, organizational and management structures at both the national and local levels for this operation.
6. Developing a Management Information System (MIS) to oversee and ensure effective implementation, evaluation and improvement of the EE strategy and programmes.

Constitution of a National EE Planning Group, headed by the Minister of Education or any other appropriate authority, greatly helps start the initial planning activity and, equally important, assures the necessary support personnel for its implementation. In constituting the National Planning Group, it is necessary to bear in mind that the planning and implementation of environmental education, *both formally and non-formally*, calls for not only educational professionals but also other specialists, directly or indirectly involved with environmental concerns, *as well as* different socio-economic and ethnic groups. Involvement of people with such diverse interests and competencies can ensure that elements of the eventual EE action plan are truly relevant to the environmental needs and priorities of those most affected by environmental problems.

Ten steps have been devised for the process of developing an EE action plan: (1) specification of objectives, short-term and long-term; (2) identification of target groups; (3) conceptual framework (this is so basic it might be considered as a first step); (4) programme formulation and EE curriculum development (actually the operational framework for EE), (5) institutional arrangements; (6) implementation of EE programmes and curricula; (7) inter-agency coordination mechanism (ensuring proper linkages among the different partners involved in EE implementation); (8) development of the above-mentioned Management Information System; (9) resource planning and mobilization (involving establishment of priorities, in view of almost universally limited resources); and (10) research and development (so that EE planning and programming become a continuous process keeping pace with educational and environmental developments and changes).

As can be readily seen, introduction of environmental education into the national educational system is a complex task—not least because it involves not only the formal school system but also the loosely-defined and multiple channels of non-formal education for out-of-school youth and adults. Furthermore, members of the National Planning Group have to keep in perspective the currently existing parameters and situation of the nation's education efforts and try to integrate the environmental dimension into them. This may well require at times redefining the parameters and re-designing the basic components of the educational system which clearly poses a major problem for all educational planners of most countries.

Moreover, it can be seen that planning a national EE programme is not just a one-time affair Rather, it must be a continuous process with a built-in capacity to adapt itself to the changing demands of the environment of the country as well as educational developments. Thus, the National Planning Group must present short-term EE action plans as well as a dynamic, self-correcting, long-term perspective for the nation's environmental education.

The next set of tasks, as has been pointed out, relate to evolving a suitable management system for implementing the action plans developed. This in turn involves identification of appropriate points in the existing educational system for introducing and integrating the EE components. It may also involve creation of new structures for providing the necessary organizational and academic support for implementing the EE programmes.

A major task is to create a management system which effectively encompasses field-level institutions and environmental activists. This requires considerable ingenuity on the part of the National EE Group to achieve a workable combination of planning and management strategies which incorporates effective vertical as well as horizontal linkages among the different agencies, institutions and individuals. The key factor is to mobilize and sustain community participation in all EE programmes, whether they are being implemented in the formal or non-formal educational process. This is imperative if environmental education is to be freed from the usual problems involved in introducing educational innovations, such as EE, through the hierarchical, bureaucratic structures that are so often characteristic of educational administrations in many countries.

It follows that EE planning and implementation urgently require an openness and breadth of scope on the part of educational authorities, at both the national and the local level. Indeed, it is at the local level that administrators ensure that national plans and policies concerning environmental education are truly implemented *and effectively updated* by their providing a continuous feedback to national planners regarding local realities. It is thus essential that there be training programmes to develop the necessary EE knowledge, skills and environmental attitudes among key personnel working at the various levels of educational planning and administration.

Courtesy: *Connect*

A Discriminatory Study of Achievement of Students in Physics Taught through Lecture Model and Individually Guided System of Instruction

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The Mastery Learning Strategy (MLS) of classroom instruction in physics, based upon the concepts of structured subject matter, self-pacing, peer-tutoring, individual guidance and criterion-testing, has positive cognitive consequences The present study of implementing mastery-based Individually Guided System of Instruction (IGSI) in physics developed by the NCERT has revealed that an achievement test in physics loses its discriminatory power under the mastery learning situation Thus, IGSI-physics can be helpful in making learning optimal by shifting more students to higher grades of achievement.

Introduction

Based upon the mastery learning concept (Keller, 1968; Bloom, 1971), the National Council of Educational Research and Training (NCERT) developed an instructional material in physics called the Individually Guided System of Instruction (IGSI). It has been reported by some investigators (Mathur, 1983; Hooda, 1984; Kaundal, 1984) that the mastery based instructional procedures have positive cognitive consequences.

A review of the studies done on IGSI reveals that hardly any investigator has tried to find the efficacy of this instructional model on achievement (Kishore, 1986). Therefore an attempt was made to investigate the effect of IGSI on achievement by finding the change in the discriminatory index of a teacher made achievement test by implementing this instructional model.

It will be appropriate here to throw more light on the IGSI-physics material which was used for the present study. IGSI-physics in the instructional material structured into sequential learning blocks called study units. The student paces himself through the study units with his difficulties removed by taking individual guidance from the peers and the instructors. As and when the student thinks that he has mastered his ongoing unit, he takes a mastery test on the unit which he should pass with more than 80% marks before he is allowed to proceed on to the next unit

Objectives of the Study

The present study entails the following objectives:

1. To study the effect of IGSI on achievement in physics.
2. To study the effect of IGSI on high cognitive entry behaviour group of students.
3. To study the effect of IGSI on the low cognitive entry behaviour group of students.

Hypotheses

The following hypotheses stated in the null form were tested:

H1: There will be no significant variation in the discriminatory power of the test after the IGSI treatment.

H2: The number of wrong answers by the high group students would not decrease after the IGSI treatment.

H3: The number of wrong answers by the low group students would not decrease after the IGSI treatment.

Tools

The following tools were used for the present study:

1. Cattell's culture fair intelligence test (reliability = .87, concept validity = .85, concrete validity = .77).
2. An achievement pre-test in physics developed locally by the investigators (split half reliability = .65; number of test items = 50).
3. An achievement post-test in physics developed locally by the investigators (split half reliability = .68; number of test items = 50).

Sample

Fifty students of Class XI studying in the Motilal Nehru School of Sports, Rai (Haryana) constituted the sample for the study. The age of the students ranged from 15 to 17 years. The two comparison groups, consisting of 25 students each, were matched on intelligence The high and low groups of students comprised of 25% of the high and low rankers on the pre-test scores. These groups consisted of six students each.

Procedure of Study

The study was done using the 'control and experimental groups design'. The experimental group was taught physics through the IGSI and the control group was taught through the lecture model. The investigator taught both the groups. For the experimental group, the prescribed guidelines for implementation of IGSI were followed with 80% marks as the criterion for mastery.

The post-treatment achievement test was administered after six weeks of IGSI course to investigate the change in discriminatory index of the test.

Statistical Computations

The statistical computations for matching the two comparison groups were done by the t-test and level of significance of the difference in their intelligence. Also, the discriminatory index of the pre-test and post-test were found before and after the experiment for the two comparison groups.

It will be proper to explain the discriminatory index at this point. The discriminatory index of test is its ability to discriminate the students of different achievement levels. For calculating the discriminatory index the following formula (Lindeman, 1971) was used:

$$D = \frac{WL - WH}{N}$$

TABLE 1
Pre- and Post-treatment Discriminatory Index of Achievement
Two Comparison Groups ($N = 12$)

Group	Test	Mean Wrongs in Low Group WL	Mean Wrongs in High Group WH	Discriminatory Index $D = \frac{WL - WH}{N}$
Control	Pre-test	16	9	.58
	Post-test	14	8	.50
Experimental	Pre-test	16	10	.50
	Post-test	10	8	.17

where D is the discriminatory index, WL is the mean of wrongs in the test for the low group, WH is the mean of wrongs in the test for high group and N is the total number of students in high and low group.

A test is able to discriminate between the students of different achievement levels effectively if value of the discriminatory index is between 0.4 and 0.6.

Findings

The findings of the study are summarised in Table 1.

The following interpretations emerge from the findings of the study:

1. The discriminatory index of the control group following the lecture method of instruction after the treatment changed from 0.58 to 0.50. Thus, for the control group the discriminating index remained between 0.40 and 0.60.

   On the other hand, the discriminatory index of the test showed a drastic change from 0.50 to 0.17 for the experimental group, thereby rejecting hypothesis H1.
2. For the high group of the experimental group following IGSI, the mean number of wrongs in the answers of the test items changed brought about insignificant variation the discriminatory index thereby accepting hypothesis H2.
3. For the experimental low group the mean wrongs in the answers of the test items decreased from 16 to 10 thereby rejecting hypothesis H3. (It should be noted that 10 is the mean wrongs of the high group of the control group).

   This change brought significant variation, in the discriminatory index. Thus, the test which was good in the lecturing situation, lost its discriminatory power in the mastery-based instructional setting.

Discussion

The findings, thus, reveal that IGSI has positive effect upon achievement in physics; and more so for the low group students. In other words, the low achievers when treated with IGSI move towards high group. Similar effect of mastery learning models has been reported by (Yadav, 1984; Kaundal, 1984; Kishore, 1986) using the t-test and U-test techniques. It seems that the insistence on mastery, self-pacing, individual guidance, peer-tutoring (the built-in features of IGSI) have positive cognitive effects on students. It also becomes evident that in lecturing situation students learn no more than they would otherwise learn by mere chance. On the other hand, in the mastery learning situation, more students achieve higher grades It may be concluded that IGSI is a superior method of instruction than the lecture method.

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Students' Query About the Number π

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In order to facilitate teaching-learning process, this paper presents a detailed information about the number π in the historical context of its evolution.

A common query has been raised by several students of age group 11+ to 13+ about the number π viz., 'why do we say π is an irrational number and take its value 22/7, which is a rational number'? They have shown by simple division algorithm that 22/7 is $3.\overline{142857}$, a non-terminating but recurring decimal number. A simple answer to this query that the rational number 22/7 is only an approximate value of π taken for computational purposes does not seem to serve the purpose. One needs to find the root cause of this query. For this purpose a survey was conducted in schools with the intention to probe into classroom teaching methodology which might have led to this serious misconception.

Three schools of different category, viz., unaided, aided and government schools of Union Territory of Delhi of south campus were randomly selected for conducting the survey. A small sample of ninety students of Class VIII, thirty from each school, was chosen and a test was conducted in the usual classroom situation. The students were asked to write in detail the meaning, definition and uses of the number π. It was observed that, on the whole students were lacking the basic understanding about the number π. Only 5 per cent could give correct definition, emphasising that its value is taken 22/7 *approximately* for calculation purposes. Discussion with teachers regarding the poor performance of the students revealed that the number π is casually mentioned in the classroom teaching as and when its reference comes in the textbook. No efforts are made to explain its historical development and applications since such information is not available in the instructional material. It was concluded that the root cause of the students' misconception about the number π has arisen due to inadequate teaching in the classroom and lack of reading material dealing with such concepts in the schools.

In order to facilitate teaching-learning process this paper presents a detailed information about the number π in the historical context of its evolution.

The most famous problem in the history of mathematics is 'squaring the circle', that is, constructing a square equal in area to that of the given circle. This problem has exercised a greater or longer attraction of researchers in mathematics right from the infancy of geometry. The problem of finding area had its genesis in the daily life situations for example when measuring of area of agricultural field had become a necessity in the Nile valley as each year the floods would blot out every mark made by the farmers. To cater to these needs, methods were devised to find the area of a figure bounded by straight lines. But tremendous difficulties were faced in finding the area of a figure bounded by curved lines. So every problem of this type was reduced into one of measuring areas with straight edges first. This way the problem of 'squaring the circle' originated. Clearly, if a square can be constructed with the area of a given circle, by measuring the area of the square, that of the circle is determined. The expression squaring the circle derives its name from this approach and is the first problem which involves π. The number π (pi), a Greek alphabetical symbol, is the ratio of the circumference of a circle to its diameter. The area of a circle of radius r is πr^2 and the areas of the square of side A is A^2. The algebraic expression

$$A^2 = \pi r^2$$

or

$$A = r\sqrt{\pi} \qquad ...(1)$$

expresses the equivalence in area between the square and the circle. Hence for a given radius of the circle the problem of squaring the circle basically reduces to the computation of the value of π. The first scientific attempt in this direction seems to be due to Archimedes who is usually remembered for his mechanical inventions in the area of mechanics and hydrodynamics, but his contribution to mathematics was significant in his times. He calculated the value of π by the method known as the 'process of exhaustion'. This method was first used by Antiphon by drawing regular polygons inside the circle (see Fig. 1) by successively doubling the number of sides until the area between inscribed regular polygon and circle was approximately exhausted. But he could not find the solution.

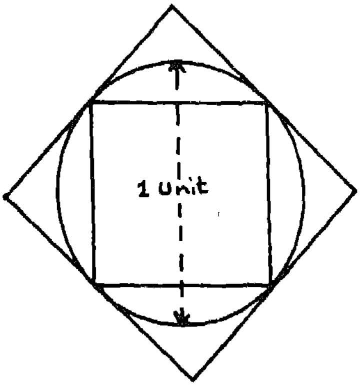

Fig. 1

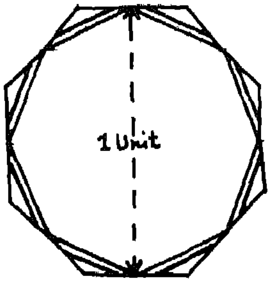

Fig. 2

Archimedes improved upon his method by inscribing and circumscribing regular polygons, as shown in Fig 2, to find the limits within which the circumference of a circle must lie. By successively making these limits draw closer and closer to each other he found that the values or π lie between 223/71 and 220/70. That is, the circumference of a circle was little more than 223/71 times its diameter and little less than 220/70 times its diameter. It can be shown by calculations or careful measurements that as the number of sides in the polygons increases, the difference in the perimeters of circumscribed and inscribed polygons decreases. The perimeters of such polygons for a circle of unit diameter are tabulated in Table 1.

TABLE 1

Number of Sides	Perimeter of Inscribed Circle P_i	Perimeter of Circumscribed Polygon P_c	Difference $P_c - P_i$	Value of π $\pi \approx \frac{1}{2}(P_i + P_c)$
4	2.8 Units	4.0 Units	1.20	3.4
6	3.0 ″	3.46 ″	0.46	3.23
8	3.0 ″	3.3 ″	0.30	3.19
12	3.1 ″	3.2 ″	0.10	3.6
18	3.135 ″	3.173 ″	0.078	3.15
24	3.13 ″	3.16 ″	0.03	3.145
36	3.139 ″	3.15 ″	0.011	3.144

Archimedes used regular polygons with 96 sides in order to get best possible approximation for π. Since then several researchers have worked on this problem. They include Tsu Chung-chih of China, Aryabhata and Bhaskara of India, Ptolemy of Alexandria. French mathematician Francois Viete found the value of π correct to ten decimal places using polygons having 393.216 sides. He also discovered the following interesting infinite product

$$\frac{2}{\pi} = \frac{\sqrt{2}}{2} \frac{\sqrt{(2+\sqrt{2})}}{2} \frac{\sqrt{[2+\sqrt{2}+\sqrt{2}\,]}}{2} \cdots$$

Adrianus Romanus of Netherlands using 2^{30}-sided polygons found the value of π correct to 15 decimal places, whereas Rudolph Van Ceulen of Germany computed the value correct upto 35 decimal places using 2^{62}-sided polygons. But the number π reached its maturity with the invention of calculus. the Greek method was abandoned and purely algebraic device of convergent infinite series, products and continued fractions came into vogue. The English mathematician John Wallis obtained the following expression

$$\frac{\pi}{2} = \frac{2 \cdot 2 \cdot 4\ 4 \cdot 6 \cdot 6 \cdot 8 \ldots}{1 \cdot 3 \cdot 3 \cdot 5 \cdot 5\ 7 \cdot 7 \ldots}$$

and Lord Brouncker converted this expression into continued fraction

$$\frac{4}{\pi} = 1 + \cfrac{1^2}{2 + \cfrac{3^2}{2 + \cfrac{5^2}{2 + \ldots}}}$$

The infinite series,

$$\text{arc tan } x = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \ldots,\quad (-1 \le x \le 1)$$

obtained by Scotch mathematics James George viz., becomes for $x = 1$ the Leibniz's infinite series

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \ldots$$

The successive products and sums of the terms of these series yield values of π as accurately as desired.

Count Buffon, the eighteenth-century naturalist, in his most famous 'Needle Problem'

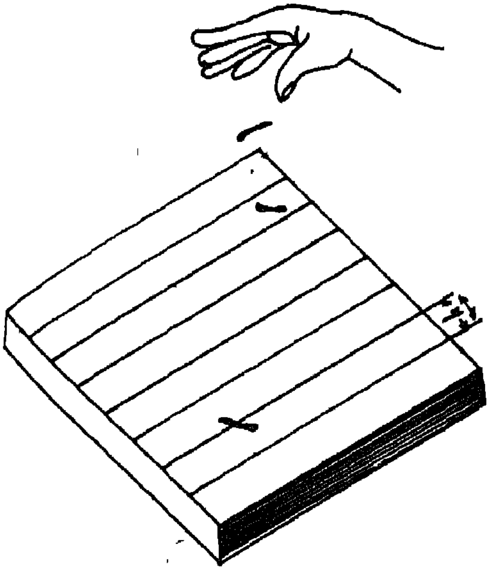

Fig. 3

experiment showed π as a measure of probability He took a plane surface (see Fig. 3) which is ruled by parallel lines, the distance between the lines being equal to *d*. Taking a needle whose length *l* is less than *d*, Buffon dropped it on the plane surface permitting it to fall each time on the ruled surface. The toss was considered favourable when needle fell across a line, unfavourable when it rested between two lines. The ratio of successes to failures was an expression in which π appears. The larger the number of trials the more closely did the result approximate the value of π. An Italian mathematician Lazzerimi elaborated this experiment by making 3,408 tosses giving a value for π equal to 3.1415929, an error of only 3×10^{-7}.

We have seen π in three guises; as the ratio of the circumference of a circle to its diameter, as the limit of infinite series and as a measure of probability.

Value of π correct up to 2035 decimal places was obtained in 1949 by using Electronic Calculator ENIAC at the Army Ballistic Research laboratories in Aberdeen, Maryland, USA. More accurate calculations of π with the help of computer are being carried out by researchers with different methods these days. It may be noted that $\pi \neq 22/7$; the number $\pi \approx 22/7 = 3.14$ gives value of π correctly only up to the hundredth place which is good approximation for routine computation. The above historical background has shown that for centuries mathematicians studied and investigated the properties of π. It took about four thousand years to find exactly what kind of number it is. It was Lambert who first proved rigorously that the number π is irrational. He showed that if x is rational, but not zero, then $\tan x$ cannot be rational, since $\tan \pi/4 = 1$, it follows that $\pi/4$ or π cannot be rational. C.L F. Lindemann in 1882, proved the transcendentality of the number π He showed that the number is not only not the root of first or second degree algebraic equation but is not the root of any algebraic equation. Thus π is a transcendental number. Here, then is the end of every hope of proving the classical problem 'squaring the circle' in the intended way, a mathematical impossibility.

The idea of the number π helps to find area of a circle. It also helps us to find the circumference of a rim of a wheel if we know the spoke or what size of spoke we need to make a rim which turns so many times in a km and the importance of wheel is well known. It is the basis of the cyclometer (the first model of which was made in Alexandria about 100 B.C.) and the speed indicator. It is also the basis of large earth measurements and estimates of the size of sun and the moon. Lastly one can rightly assert that without π there would have been no Columbus and no George Stephenson.

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Nobel Prizes in Science for 1990

Nobel Prize gold medallion and diplomas were presented by King Carl XVI Gustav of Sweden to ten laureates in Physics, Chemistry, Medicine, Literature, Peace and Economics A special ceremony was held on 10th December, 1990 The names of recipients were announced earlier in the month of October.

Instituted by the will of a single person, Alfred Nobel, the famous Swedish chemist and inventor of the dynamite, the Nobel Prize is awarded every year to the persons who have made greatest contribution towards human welfare in different fields. The award was made for the first time in 1901 from the fabulous fortune left by Nobel for the purpose.

The Nobel Prize is now considered the highest international recognition Though finally judged by a few represented on committees, academies and institutes located at a small corner of the world, the award is looked upon as universal appreciation of genius Fortunate are the persons who receive such an honour in their life time. Proud are the countries who hold them. The prize also makes a good piece of work known, understood and appreciated in a much wider circle. The money and recognition attached to the award has helped many in carrying out further research.

Here is a glimpse of the Nobel Prize winners of 1990 in Physics, Chemistry and Medicine together with brief outlines of their work.

Editor

Physics Prize Awarded to Two Americans and a Canadian

The Noble Prize in physics for the year 1990 has been awarded to two U.S. scientists and a Canadian for breakthrough discoveries about minute particles that form more than 99 per cent of all matter on Earth.

The Royal Swedish Academy of Sciences announced October 17 that Americans Jerome Friedman, 60, and Henry Kendall, 63, both professors at the Massachusetts Institute of Technology, and Canadian Richard Taylor, 60, a professor at Stanford University, shared the 700,000-dollar award

The academy said that the three physicists, in pioneering work carried out during the late 1960s and early 1970s, were the first to find evidence of quarks, now believed to be the basic building blocks of matter.

"Here was a repetition, although at a deeper level, of one of the most dramatic events in the history of physics, the discovery of the nucleus of the atom," the academy said in its citation. It added that their work "paved the way for further investigations of the innermost structures of matter."

The physics laureates showed that the protons and neutrons that make up the nucleus of an atom, and formerly thought to be fundamental particles, were made up of even smaller components called quarks. The discoveries were made using the Stanford Linear Accelerator, an "atom smasher" that produces high-speed collisions of subatomic particles in an effort to discern their properties and structure.

Atoms that make up all familiar matter consist of tiny subatomic particles. Protons, carrying a positive electric charge, and electrically neutral particles called neutrons, cluster within the atom's central region or nucleus. Whirling around the nucleus is a third subatomic particle,

Fig. 1. *Three North American scientists whose experiments confirmed the existence of quarks—tiny packets of energy described as fundamental building blocks of all matter—shared the 1990 Nobel Prize in Physics. Dr. Henry W. Kendall (left) and Dr. Jerome I. Friedman (centre) are professors at the Massachusetts Institute of Technology. Dr Richard E. Taylor (right), a Canadian, is on the faculty of Stanford University, in California, where the three met as graduate students. The physicists' experiments at Stanford's Linear Accelerator Center from 1967 to 1973 achieved a "breakthrough in our understanding of matter," according to the Nobel Committee.*

the electron, which carries a negative charge. Electric current consists of flowing electrons.

Physicists now know that protons and neutrons are made up of combinations of quarks, bonded together according to their "colour", a special property that enables quarks to join and form new particles. A quark's electric charge determines its "flavour"—whether it is "up" or "down".

A proton consists of two "up" quarks with a positive charge of two-thirds each and one "down" quark with a negative charge of one-third, together yielding a single positive charge. In a similar way, one "up" and two "down" quarks combine to form a neutral neutron.

More recently researchers have discovered special kinds of matter that are different than the type from which the everyday world is made. These fundamental particles, which include quarks called "charmed", "strange", "top", and "bottom", are created by high-energy particle accelerators or carried by cosmic rays.

Friedman told reporters that the research he and his colleagues performed represented the first experimental evidence that quarks existed and confirmed earlier theories. The breakthrough research began with the study of protons.

"To our surprise, we found that the scattering of electrons from protons behaved in a way that suggested that there were point-like objects inside, little nuggets inside," he said. "They were later identified ... as being compatible with there being quarks."

Friedman said that their research contributed to an understanding of how nature works.

"One never knows what the application of basic research will be," he said. "Knowing what the structure of matter is ultimately has to have some effect on how you model the entire structure of things."

Taylor, who was born in Medicine Hat, Alberta, Canada, noted that their research, involving the acceleration of protons in order to better examine their structures, started an even longer process where more quarks were discovered

"This was one step in the chain to forge that essential understanding we have now of the elementary particles," he said.

Ingvar Lindgren, a member of the Royal Swedish Academy, told reporters that although the research has had little immediate practical application, the new understanding of nature it provided helps researchers in many scientific areas.

"This is ground research which has increased our understanding of nature and changed our picture of the world," he said.

Nobel Chemistry Prize

A U.S. scientist has won the Nobel Prize in chemistry for research that simplified the production of plastics, drugs and other products used throughout the world.

The Royal Swedish Academy of Sciences said on October 17 that it awarded the prize worth about 700,000 dollars to a 62-year-old professor at Harvard University, Elias Corey, for developing simpler ways to make complex chemicals. Corey was also one of the first to use computer graphics to speed up the synthesis of new chemicals.

The academy cited Corey for "his development of the theory and methodology of organic synthesis " Organic synthesis is the production of complicated biological compounds using simple and inexpensive starting materials.

The academy said that Corey synthesized about 100 important drugs and other natural products, and that his research simplified the production of plastics, paints, dyes and pesticides. These products "have contributed to the high standards of living and health and the longevity enjoyed ... in the Western World," the academy said.

Corey's method of synthesizing chemicals is called retro-synthetic analysis. This involves taking a chemical structure and manipulating it in the laboratory in a stepwise way to identify a series of simpler molecules needed to construct the original compound.

This direction of thinking was the reverse of the usual way of thinking of synthesis, which involved starting out with simpler compounds in an attempt to form a more complex substance. Corey's initial work, which made use of formal strategies that involved a minimum of trial and [illegible], was often greeted with ridicule by colleagues who thought natural products were too complex to be dealt with in such a manner

In the mid 1960s, Corey also became the first to use computer graphics to portray chemical structures and developed the beginnings of machine generated retro-synthetic analysis. Today computers and laser printers are used throughout the world to generate models of possible chemical structures and speed up the creation of new products.

Fig. 2. *The laureate in Chemistry, Dr. Elias James Corey (left), of Harvard University, was honoured for developing new ways to synthesize complex substances, including pharmaceuticals, patterned after natural molecular structures.*

In early 1968 Corey completed the first synthesis of prostaglandins, a group of fatty acid derivatives affecting many body tissues and organs including the prostate gland, brain, lungs, kidneys, thymus and pancreas. However, the availability of these biological regulators from natural sources for therapeutic use was extremely limited.

"The first synthesis was done with practically no knowledge of the chemical properties of these compounds," Corey told reporters recently. "Such small quantities had been available that there was very little information in the literature."

Just last year Corey described six major synthesis, including a total synthesis of an extract from the *Ginkgo biloba* tree, which could prove to be a treatment for several conditions ranging from asthma through mental dysfunction to various circulatory disorders.

Corey sees an exciting future for organic chemistry in the decades to come. "It will encompass areas outside the traditional ground, towards biology, medicine, genetics and the many elements available in the Periodic Table," he said recently. "The revolution that this decade has seen will continue into the next 50 years. The growing power of modern synthesis will be central to the development of therapeutic agents for years to come."

Corey, born in Methuen, Massachusetts, in 1928, earned his doctorate degree in chemistry at the Massachusetts Institute of Technology in 1950. He has been a professor at Harvard University since 1959.

U.S. Transplant Pioneers Awarded Nobel Medicine Prize

The Nobel Prize for Medicine has been awarded to two U.S. doctors who pioneered the first successful organ and bone marrow transplants to save the lives of severely ill patients.

The 730,000 dollar prize would be shared by 71-year-old Dr. Joseph Murray, a surgeon at the Brigham and Women's Hospital in Boston, who performed the first kidney transplant, and 70-year-old Dr. E. Donnall Thomas, a researcher at the Fred Hutchinson Cancer Research Center in Seattle, who perfected the use of bone marrow transplants to treat leukemia and other diseases.

"Murray's and Thomas' discoveries are crucial for those tens of thousands of severely ill patients who either can be cured, or be given a decent life when other treatment methods are without success," the institute said in its official citation. "This year's laureates paved the way for transplantation in man."

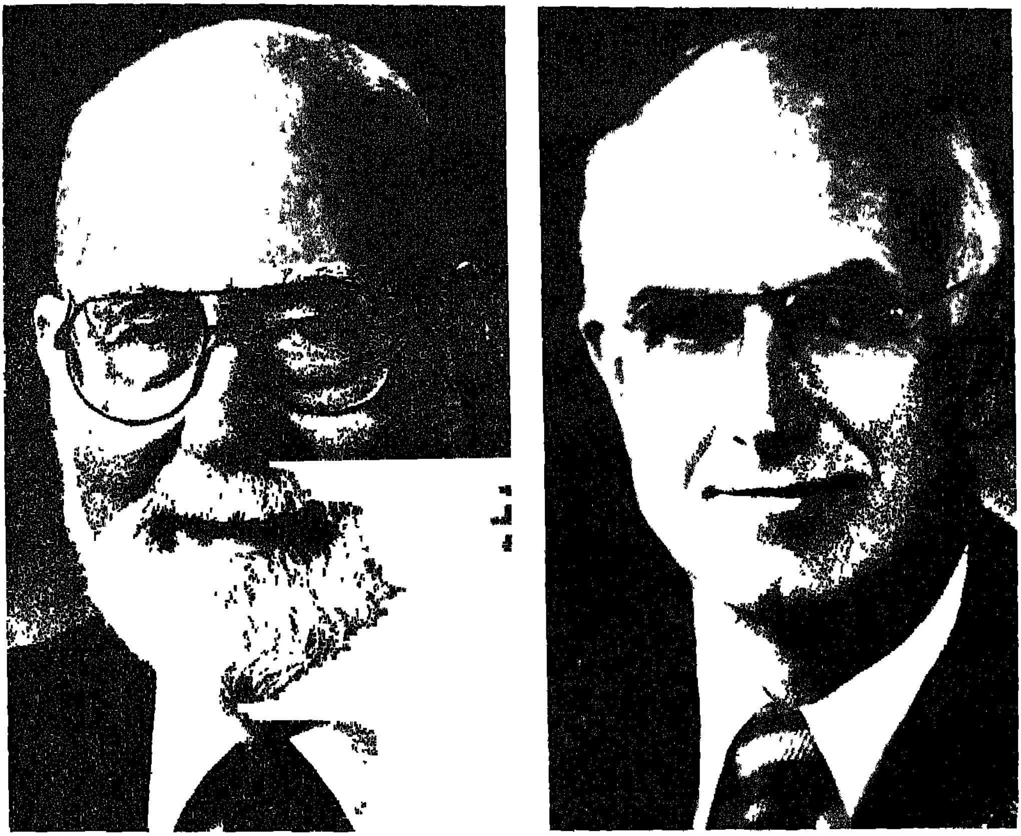

Fig. 3. *Two Harvard-trained physicians shared the Nobel Prize in Medicine for their pioneer life-saving transplants in the human body. Dr. Joseph E. Murray (right) and Dr. E. Donnall Thomas (centre) were residents together at Boston's Peter Bent Brigham Hospital, where Dr. Murray still practises. He solved the problem of organ rejection and in 1954 made the first successful organ transplant, a kidney from one identical twin to another. Dr Thomas, now with the Fred Hutchinson Center in Seattle, Washington, performed the first bone marrow transplant in 1956.*

In December 1954, Murray performed the first human kidney transplant on two men who were identical twins, thus presenting no immunological problems. The landmark operation began the era of transplant surgery. The field gained broader application when in 1962 Murray and several colleagues succeeded in solving the problem of organ rejection using the immunosuppressive drug azathioprine.

The first success transplanting an unrelated cadaver kidney into a live patient was achieved in 1962, and by 1964 the success rate of transplanting kidneys from unrelated donors had reached 75 per cent. Murray's colleague in this work, chemist Dr. George Hitchings, won the 1988 Nobel Prize for developing azathioprine and other life-saving drugs.

Murray, who began experiments transplanting kidneys between dogs in the 1950s, told reporters that his research initially met with great skepticism from other scientists who doubted that the body's immune system would accept a foreign organ. Today tens of thousands of patients have kidney transplants each year. Murray's work showing that kidney transplants could work led surgeons to begin transplanting other vital organs.

Murray also spent part of his time as a plastic surgeon, concentrating on patients who had been in serious accidents or had birth deformities. He introduced into the United States a procedure that corrected head deformities by resectioning and moving the bones of the head and face forward.

Thomas pioneered the bone marrow transplant procedure, a therapy that is now considered the only hope of survival for tens of thousands of patients with certain leukemias and other blood-related and genetic disorders.

Bone marrow refers to the soft tissue found in the hollow centre of many human bones that produces blood cells and platelets. In leukemia some of the body's white blood cells become cancerous and gradually crowd out the normal blood-producing cells of the bone marrow.

Thomas pioneered a technique by which leukemia patients were given a healthy supply of bone marrow after their own diseased or damaged blood cells were killed by high-dose chemotherapy. Thomas began with identical twins, performing the first bone marrow transplant in 1956. Later he demonstrated that transplants also could be done between unrelated individuals, provided that the immune systems of the donor and recipient could be carefully matched.

"In the 1950s, most people thought this would never succeed," he told reporters. "And in the 1960s, even people who had worked on it in the 1950s had given up. But we were convinced it could work."

As director of the Hutchinson Center's clinical division for over 15 years, Thomas headed the largest marrow transplant program in the world. Doctors at the center perform 350 transplants a year.

Thomas, born on March 15, 1920, in Mart, Texas, received his medical degree from Harvard Medical School in 1946. In 1963, Thomas organized and became the first head of the University of Washington School of Medicine's Division of Oncology. He was director of oncology for the Hutchinson Center from 1974 to 1989. He is married with three children.

Murray, born on April 1, 1919, in Milford, Massachusetts, also earned his medical degree at Harvard University. He trained as a plastic surgeon and became interested in transplants during World War Two, when he grafted skin onto wounded soldiers. Murray is currently professor of surgery emeritus at Harvard Medical School. He is married with six children.

Acknowledgement: Jim Fuller, USIS

Science News

A Galaxy Discovered

A team of astronomers from Durham University in north-east England has discovered a new galaxy which is said to lie half way to the edge of the universe, says a British Science and Technology news report. Professor Richard Ellis, Dr. Jeremy Allington-Smith and Mr. Ian Smail were able to look much farther into space by using the Anglo-Dutch William Herschel telescope in the Canary Islands, in combination with a gigantic natural "magnifying glass".

The three men, knowing that light rays are bent by massive objects, have been using relatively nearby clusters of galaxies as natural cosmic lenses to examine the detailed properties of very remote galaxies which cannot be seen any other way.

Prof. Ellis said "these clusters are akin to magnifying glasses lying in space. Once we know they are there, we use the Herschel in combination with them to see much farther in space than would otherwise be possible."

The new galaxy was discovered during an investigation of distorted images that were seen as two faint arc-like features in the direction of a galaxy cluster known as Abel 963. The Durham astronomers showed that the mysterious arcs in fact represented light from a previously unknown galaxy much farther away than Abel 963, which was acting as cosmic lens magnifying and distorting the light of the background galaxy.

By using its gravitational force, Abel 963 acted like a lens to focus light from the new galaxy into the Herschel telescope. This created a "gravitational telescope" 2,000 million light years long, through which the astronomers were able to see what they described as a spiral galaxy half way back to the origin of the universe.

Distant galaxies such as this, seen as they were when the universe was young, are regarded as important clues to unlocking the mystery of how the universe was created. If more natural lenses like this can be discovered, they can be used as gravitational telescopes systematically to study the history of the universe

Bending light by gravity and the existence of gravitational lenses were predicted by Albert Einstein, but their practical use in conjunction with large astronomical telescopes is new. The 4.2 metre Herschel telescope is world's third largest optical telescope.

Villagers Suffer from Intestinal Diseases

Up to 60% of the rural population of India suffers from various intestinal diseases caused by work infestations and protozoal infections, a leading gastro-enterologist has said.

Addressing the 31st national annual conference of the Indian Society of Gastro-enterology, Prof. B.N. Tandon said infestations with roundworm, hookworm and strongloides and infections with *Amoeba historytica* and *Giardia* were most common among rural people.

He said worm infestations led to various gastro-intestinal problems like pain in the abdomen, diarrhoea, dysentery besides protein caloric malnutrition and deficiencies of vitamins, minerals and trace elements.

The protein calorie deficiencies in turn could promote these infections creating a vicious cycle. Hookworm led to anaemia and hypoproteinmia and amoebiasis could cause liver abscess complication.

Under the circumstances the need for proper sanitation, provision for safe drinking water, frequent administration of deworming agents and good nutrition for the prevention of these diseases are to be assured.

Spinal Tuberculosis Can be Cured by Medicine

Spinal tuberculosis can be cured within six to nine months by chemotherapy alone, it has been established in a study at the Tuberculosis Research Centre in Madras. About 300 patients suffering from spinal tuberculosis were involved in the study carried out at six Government hospitals in Madras.

This finding has immense implications for the management of spinal tuberculosis, the commonest form of extra-pulmonary tuberculosis, said the TRC director, Dr. R. Prabhakar.

Until recently patients of spinal tuberculosis were put on traction, subjected to risky surgery and hospitalized for up to 2 years. Being highly specialized this surgery can be done only in very few orthopaedic centres in India.

The 10-year Indo-British Joint Study at TRC has now concluded that surgery is unnecessary to treat tuberculosis affecting the spine below the neck.

The study found that a combination of potent drugs used to treat tuberculosis of the lung can also cure spinal tuberculosis. Patients can also be treated at home or in a general hospital, rather than a specialized orthopaedic centre.

Chemotherapy eliminates the risk of surgery. Patients can go back to work early, because no hospitalization is necessary. The pressure on the family is also reduced.

Sun-tanning is a Cancer Hazard

Advertisements using bronzed models should be required to carry health warnings that sun-tanning can cause skin cancer, medical specialists said. The advertising, fashion and marketing industries are irresponsibly promoting tans, counteracting efforts to encourage Australians to reduce their skin cancer risk, the Australian College of Dermatologists said.

"Much magazine advertising still uses tanned models which perpetuates the myth that a suntan is a fashion item, healthy and attractive. This is the message that thousands of men and women, teenagers and children get everyday, every time they open a magazine. I believe that each of these pictures should in fact carry a warning, similar to those found on cigarette packets: sun-tanning is a cancer hazard," said the honorary secretary of Dr. Alan Cooper College.

Mr. Cooper called for a concerted effort to promote the image that "the pale Australian is in, and the bronzed Aussie is out. It is hoped that the tan will no longer be the accessory that 1,000 people each year wear for their funeral."

The Australian industry was lagging behind overseas trends as it is difficult for tanned models to get work in Europe. Most Australian models who develop tans could expect to develop skin cancer, and that many would suffer "significant, noticeable, ugly changes" to their skin as early as their late 20s.

Mr. Cooper also criticized parents who do not protect their children from the sun. "When I see parents with very young babies on beaches with no protection, I think that is child abuse," he said.

Unlocking the Hidden Energy in Plants

Lignin, which livestock can't digest, gives plants their structure and rigidity. It's the substance that cements cellulose and hemicellulose in and around plant cells like mortar and concrete hold bricks in a wall.

Because it ties up the energy in cellulose and hemicellulose, lignin is the most limiting factor in forage digestibility.

Forages supply more than 60 per cent of all energy consumed by dairy cattle; for beef cattle, it's 80 per cent, so making forages more profitable is a key part of the research of many agricultural scientists.

Many solutions to the problem of breaking lignin's bonds have been suggested. These range from traditional plant breeding and dowsing plants with a common household antiseptic and bleach to hitting crops with laser beams.

In the mid-80s, an American chemist at the Northern Regional Research Center in Peoria, Illinois, began treating crop residues such as hay and corn stalks with hydrogen peroxide—a common household antiseptic and bleach. The effect was greater digestibility due to degradation of lignin by the bleach. This process has since been refined and adapted for commercial use.

An Agricultural Research Service (ARS) agronomist, James R. Forwood, is currently using high technology to tackle lignin According to him microorganisms in an animal's rumen break down fibre faster if forage has had tiny holes punched in it by laser beams.

"Farmers now use grinding to break forage into more digestible pieces, and that takes a lot of costly energy. If some day, lasers become as common as calculators are today, farmers may consider replacing grinders with lasers," says Forwood.

Previous work by Forwood also showed that spraying plants with cellulose, a natural enzyme that breaks down cellulose in the animal's rumen, increased digestibility of some specific grasses by about 4 per cent.

Scientists at the ARS Russell Research Center in Athens, Georgia, are getting more information about the chemical processes in a plant that result in limited digestibility by way of a new technique using microspectrophotometry.

Microspectrophotometry replaces less accurate analyses of whole plants or plant parts by letting researchers look at individual cell walls and define digestibility.

"The problem with analyzing whole plants is that some parts are digestible, some partially digestible, and some indigestible," says ARS microbiologist Danny E. Akin.

A new area of inquiry involving the study of anaerobic fungi living in the animal's rumen is also being pioneered by the Athens group.

The anaerobic fungi—so named because they live without oxygen—don't actually metabolize lignin; they attack tissues that contain lignin during digestion. The fungi produce enzymes that in turn release phenolic compounds.

If the anaerobic fungi were given an environment in which they could be more competitive with other bacteria living in the rumen, they could better do their job of weakening lignified tissue.

"Someday we may be able to recommend certain grasses or supplements to cattle diets that would encourage the growth of these fungi in the rumen," says Akin. He is looking for fungal species of this kind in other countries that are more active than those found in U.S. cattle.

Besides plant genetics, fungi that cause wood to decay is another area of research. Some of these fungi selectively remove lignin, leaving behind a residue that is more digestible by rumen bacteria

Courtesy: *Science Update*

New Human Herpesvirus Discovered

A new human herpesvirus has been discovered by scientists at the National Institute of Allergy and Infectious Diseases in the United States. Designated HHV-7, or human herpesvirus 7, it is the seventh herpesvirus now known to infect humans. The new virus preferentially infects T cells, a type of immune system cell.

Investigations are underway to determine whether HHV-7 may be linked to any human disease. The six other known human herpesviruses—herpes simplex viruses 1 and 2, varicella zoster virus, Epstein-Barr virus, human cytomegalovirus, and HHV-6—cause a spectrum of mild to severe illness in humans, including cold sores, chickenpox, shingles, mononucleosis, and genital herpes. In rare cases, some herpesviruses can cause life-threatening encephalitis, or if transmitted to a fetus, congenital malformations. Immunosuppressed individuals can suffer unusually severe disease.

The discovery came to light when Dr. Niza Frenkel, head of the infectious diseases unit of the Institute's Laboratory of Viral Diseases, and her colleagues examined a sample of T cells given to them by Dr. Carl June of the Naval Medical Research Institute in Bethesda. He was studying these cells because they carried CD-4 markers, which the AIDS virus uses as receptors to enter T cells. The cells had been exposed to conditions that activate them, inducing them to divide.

During activation, some of the cells changed their appearance—they ballooned in size and formed small clumps of cells known as syncytia. It was clear that the cell culture harboured some infectious agent, and Frenkel and her colleagues decided to try to ferret it out and characterize it.

After isolating the infectious agent and examining it under an electron microscope, they saw clearly that it belonged to the herpesvirus family. They suspected that the virus was HHV-6, since that was the only human herpesvirus known at the time to infect T cells preferentially. Yet once they had successfully grown the virus and characterized it genetically, they found that this new virus was distinct from HHV-6, and they named it human herpesvirus 7. HHV-7's genetic makeup shows that it most closely resembles HHV-6 and human cytomegalovirus.

Viruses of the herpesvirus family, which includes the human herpesviruses, infect more than 80 different animal species. Like the other human herpesviruses, HHV-7 has a 20-sided protein-shell containing a large DNA core. The shell itself is enveloped by a membrane.

Human herpesviruses also share the property of latency—that is, the viruses remain in the body for life, though they can switch between active and dormant states. The classic example of herpesvirus latency is herpes simplex virus 1, which causes cold sores during its active phase but retreats to neuronal cells during dormancy. Upon exposure to strong sunlight, or when a person suffers from high fever, the virus becomes active, causing a recurrent cold sore or fever blister.

It was in 1986 that scientists announced the discovery of HHV-6. At that time, it was 20 years since a new human herpesvirus had been found. As scientists continue to perfect techniques for growing different cells and manipulating their function in the laboratory, Frenkel says she expects more human viruses will be uncovered. "And herpesviruses would be prime candidates for new viruses," she comments, "because they can sit there very quietly, not doing anything, until you start to change the host cell."

Courtesy: *Science Update*

Guinea Worm Eradication in India

Guinea worm maims and cripples at least 10 million people each year in India, Pakistan, and

Africa. Worldwide more than 100 million people are estimated to be at risk of the infection. The donated larvicide, worth about $2 million, is for a five-year eradication campaign to begin shortly in India and Pakistan, in addition to 18 African countries.

Guinea worm is a problem in many areas of India where tanks, *baolis* and other stagnant water bodies are used for drinking water supply. The immature guinea worm, ingested through contaminated drinking water, develops a year later into a worm measuring up to a meter in length. It causes extreme pain and disability Any part of the body can be infected. The larvicide, Abate, destroys the larvae of guinea worm in the water but leaves the water suitable for drinking.

The American Cyanamid Company has donated a large amount of larvicide for a programme aimed at eradicating guinea worm worldwide by the year 1995.

Former President Jimmy Carter, accepting Cyanamid's donation on behalf of the Atlanta-based Carter Center's Global 2000 Guinea Worm Eradication Programme, said the gift "will be instrumental in ending the unnecessary suffering of millions of people."